WAVETEK
SAN DIEGO

9045 BALBOA AVENUE, SAN DIEGO, CALIFORNIA

INSTRUCTION MANUAL
MODEL 207
DIALAMATIC
VOLTMETER / HERTZMETER

WAVETEK®

8159 ENGINEER ROAD, SAN DIEGO, CALIFORNIA

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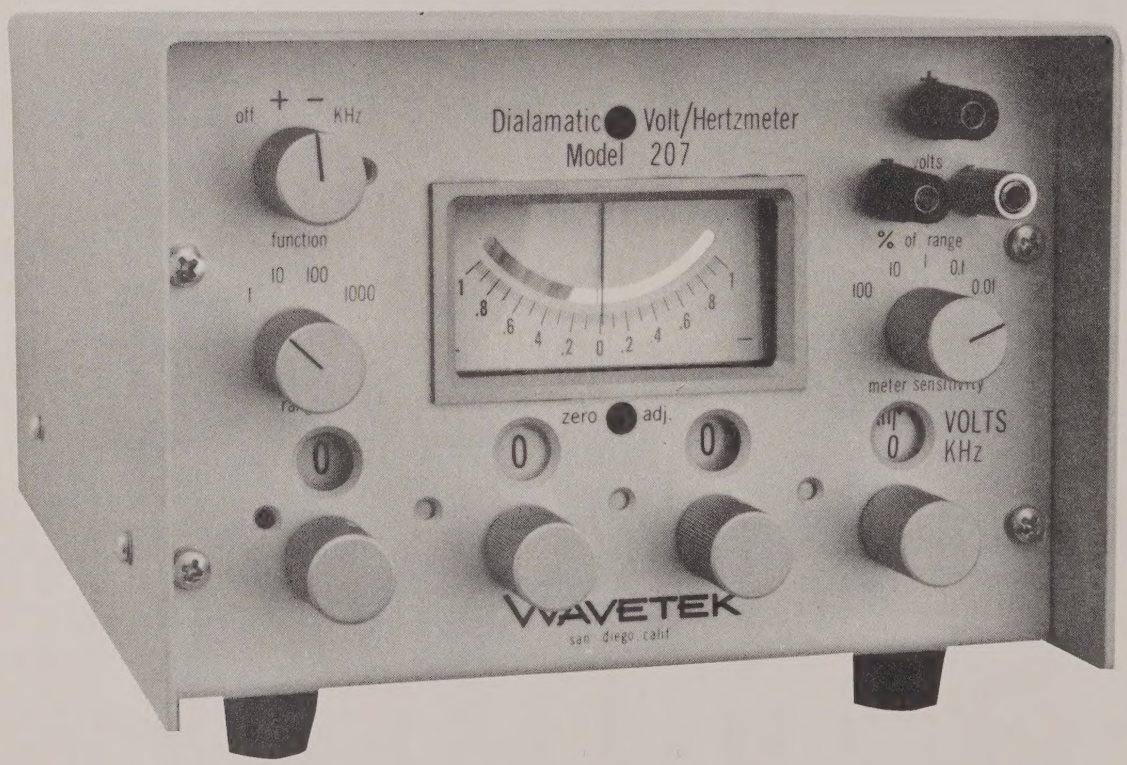
off + − KHz
function
1 10 100 1000
Dialamatic Volt/Hertzmeter
Model 207
zero adj.
volts
% of range
10 1 0.1
100 0.01
meter sensitivity
VOLTS
KHz
WAVETEK
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WARRANTY

WAVETEK warrants instruments manufactured by it to have met WAVETEK's published specifications at the time of shipment of such instruments, and agrees to repair within one year of shipment, such instruments or their components (excluding batteries), which under normal use are found to be defective as a result of our manufacturing. Our obligation under this warranty is limited solely to repairing any such instrument which in our sole opinion proves to be defective when returned to our factory. Transportation to the factory is to be prepaid by purchaser. Instruments returned to the factory will be accepted only when prior authorization has been given by a representative of WAVETEK.

This warranty does not apply to any of our products which have been repaired or altered by persons not authorized by WAVETEK, or not in accordance with instructions furnished by us. If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

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Any recommendations made by WAVETEK for the use of its products are based upon tests believed to be reliable, but WAVETEK makes no warranty of the results to be obtained. This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for us any liability in connection with the sale of our products other than set forth herein.

SECTION I
GENERAL DESCRIPTION

SCOPE

This instruction manual provides information for operation, calibration, application and maintenance of WAVETEK DIALAMATIC Differential Voltmeters.

GENERAL

The WAVETEK DIALAMATIC Differential Voltmeters are precision voltage measuring instruments that measure d-c voltages. Some models measure both d-c and a-c voltages. The DIALAMATIC Differential Voltmeter is able to measure any signal that can be converted to a d-c voltage. All models are of all silicon design and some are available in battery powered "B" versions for complete isolation from the line. With the top cover removed, the glass-epoxy printed circuit boards swing out for easy troubleshooting and maintenance. These meters are intended for bench use for which a tilting bail is provided. Optional rack mounting hardware can be provided on special order.

Full scale voltage ranges are 1, 10, 100, and 1000 volts. The voltage measurement is read out on three ten position switches and a potentiometer which displays two digits. The switches and potentiometer have an interlocking gear train which provides automatic transfer by coupling the switch being adjusted with all the switches on the left. The transfer procedure also works identically in reverse, which is particularly useful in tracking a slowly drifting voltage. With a 5-digit readout, the WAVETEK TRANSFERMATIC switch resolution is one part in 100,000. An accurate 10-volt reference voltage is obtained from a matched pair of temperature compensated zener diodes. A Kelvin-Varley voltage divider, coupled to the TRANSFERMATIC switch, provides a known adjustable reference voltage. The divider is capable of increments smaller than 10 μ volts. For input voltages greater than 10 volts the unknown is divided down by an input attenuator. Input impedance on the 100 volt and 1000 volt ranges is 10 megΩ. Because of no input attenuator on the 1 volt and 10 volt ranges, input impedance is infinite at null. Models 205 and 206, with an accurate 1000 volt reference voltage, have infinite input impedance in all ranges when at null.

A five-position sensitivity switch allows the front panel null meter to display ±100%, ±10%, ±1%, ±.1% or ±.01%* of the voltage range as a full scale reading. This provides a high degree (up to 2 ppm) of scale expansion about any point in all voltage ranges.

*Not applicable to Models 201 and 202.

When used as a differential voltmeter, these models operate on the potentiometric principle. To obtain a reading, the internal reference is divided down to equal the unknown voltage with the aid of a null meter. The unknown voltage is then read directly from the divider dials.

In the ±100% position, the instrument operates as a direct reading voltmeter. The TRANSFERMATIC switch is not connected to the null amplifier. This mode is useful for rapid and approximate voltage (±3%) and polarity measurements. For more accurate measurements, it is then only necessary to select the proper polarity and desired null sensitivity. Next, start turning the dial at the left in the direction that the meter indicator should move. When the indicator swings to the opposite side, the second dial is turned in the direction that the indicator should move. Following the same process through the dials from left to right, a null can be achieved without resetting all digits to zero and without resetting all switches when transfer points are reached.

The speed at which the voltmeter can be nulled by the operator makes the instrument ideal for use on a production line as well as in the laboratory. It is this speed of operation that makes the DIALAMATIC Differential Voltmeter unique. The increase in speed is due to the TRANSFERMATIC switch action coupled with a null amplifier which never loses sense and an amplifier-meter output indicator with sufficient band width and step response. For this reason the operator will never become confused or lose time waiting to see what effect his last adjustment is going to have on the reading.

The DIALAMATIC Differential Voltmeters have extremely high leakage resistance to ground. This minimizes the errors due to a-c and d-c common mode voltages. Other features included are a polarity switch for equal convenience when measuring positive and negative voltages and recorder output which makes the instrument useful for monitoring the stability of a-c or d-c voltages. The recorder output is proportional to the null meter reading.

In the Hertzmeter mode, the Model 207 becomes a crystal controlled frequency meter which provides accurate and sensitive frequency measurements. This Hertzmeter measures frequencies from 5 Hz to 100 MHz in four indicated ranges: 1 KHz, 10 KHz, 100 KHz, 1 MHz and two interpreted ranges which allow it to be used to measure the frequency of a signal accurately, to monitor the frequency of a signal which drifts by large or small amounts, to calibrate AF and RF oscillators or to perform many tasks where an accurate analog measurement of frequency is required.

The input signal is converted to an analog voltage proportional to the input frequency. The Kelvin-Varley voltage divider, coupled to the TRANSFERMATIC switch, provides a known adjustable reference voltage to compare with the analog signal. The known and unknown frequencies are compared and differences are indicated on the null meter. When a null has been obtained, the unknown frequency is read from the TRANSFERMATIC switch dials.

The input signal conditioning circuitry allows the frequency measurement of a large variety waveforms and amplitudes. The standard input circuitry detects the signal crossings of an axis approximately 100 mv. from the positive peak value of the waveform. This arrangement allows the dependable frequency measurement of signals that are strongly time asymmetrical, e.g. the time spent in one polarity in respect of the average value axis is much greater than the time spent in the other polarity. As an optional arrangement (on request) this circuitry may be made responsive to average value axis crossings. This allows less sensitivity to noise or amplitude modulation but reduces measurement capability of some time asymmetrical waveforms.

The modulo 100 counting circuit which is fed from an additional BNC connector located on the rear panel provides a fixed range extension of two decades. In using the meter on the divide by 100 input, the reading as indicated on the front panel must be mentally multiplied by 100 to get the correct frequency. This divide by 100 input is intended for use on signals which are roughly time symmetrical about the average value axis.

SECTION II
SPECIFICATIONS

This section contains specifications for the WAVETEK DIALAMATIC Voltmeters and/or Hertzmeters.

GENERAL

DISPLAY

Four Transfermatic digital dials, including one vernier dial calibrated to two digits, resulting in 5-digit resolution; mirror scale taut band null detection meter.

RECORDER OUTPUT

Output is proportional to null reading; ±300 mv full scale. Output impedance 10 KΩ.

ENVIRONMENTAL

Specifications apply for 25°C ±5°C. For operation from 0°C to 50°C, derate by a factor of 3.

WARMUP TIME

DC and Hertz - 5 seconds; AC - 2 minutes; all specifications apply after one hour.

POWER REQUIREMENTS

115 volts ±10% or 230 volts ±10%, 50 Hz to 400 Hz, less than 10 watts. Hertzmeters and D-C/Hertzmeters - less than 20 watts, battery models.

POWER REQUIREMENTS - Battery Models (DC and DC/AC Voltmeters only)

Ni-cad rechargeable battery with built-in charger; 115 volts ±10% or 230 volts ±10%, 50 Hz to 400 Hz, less than 10 watts. Simultaneous charge and operation; 10 hours of operation for every 16 hours of charge.

DIMENSIONS and WEIGHT

7 and 3/4" wide, 5 and 1/4" high, 11" deep

8 pounds; battery models - 10 pounds.

VOLTMETER

INPUT

0 to 1000volts d-c
1 mv to 1000 volts a-c,(Models 202, 204 and 206)

SELECTABLE VOLTAGE RANGES

1 volt, 10 volts, 100 volts, and 1,000 volts (decimal indicator automatically coupled to range switch).

POLARITY

Front-panel selected plus (+) and minus (-)

RESOLUTION

Null Meter: 2 μ volts (1 minor division on mirror scale of null meter). 20 μ volts for Models 201 and 202.
Transfermatic Switch: 0.001% of range (1 part in 100,000)

NULL RANGES

Full scale meter sensitivity is ±0.01%,*0.1%, 1%, 10%, and 100% of selected voltage range. Operates as a direct reading voltmeter in 100%. *Not applicable to Models 201 and 202.

NOTE

Normally used in most sensitive position because of non-saturating null amplifier.

D-C INPUT IMPEDANCE

Infinite at null in 1 volt and 10 volt ranges, 10 megohms in 100 volt and 1,000 volt ranges.
Infinite at null in all ranges for Models 205 and 206

A-C INPUT IMPEDANCE (Models 202, 204 and 206)

1 megohm and 40 pf.

D-C ACCURACY

±0.01% of reading ±0.001% of selected voltage range ±10 μ volts.

A-C ACCURACY

±0.2% of reading ±25 μ volts, 20 Hz to 10 KHz, 0.001 volt to 1,000 volts.

±1% of reading ±25 μ volts, 10 KHz to 20 KHz, 0.003 volts to 1,000 volts.

REFERENCE STABILITY

±0.002% after 15 minutes warmup at constant temperature and line. Temperature coefficient less than 5 ppm/°C.

COMMON MODE REJECTION

With 1 KΩ unbalance in either side of input, up to 70% relative humidity.

Voltage Ranges	Common Mode Voltage		
	DC	60 Hz	400 Hz
1 volt & 10 volt	130 db	100 db	90 db
100 volt & 1000 volt	100 db	85 db	70 db

NOTE

Ni-cad battery Models 201B, 202B, 203B and 204B provide complete line isolation.

DIRECT READING VOLTMETER (100% Meter Sensitivity)

1, 10, 100 and 1,000 volts full scale.
Accuracy 3% of full scale.

HERTZMETER

INPUT CHARACTERISTICS

Input	Sensitivity	Input Impedance
Direct	AC coupled input will accept any symmetrical waveform and negative going pulses from 250 mv peak to peak to 600v peak to peak without need for manual adjustment of slope or level. Threshold level for positive pulses increases as the duty cycle decreases.	For amplitudes less than 5v peak to peak, 1 MΩ shunted by 40 pf. For amplitudes above 5v peak to peak, 100 KΩ shunted by 100 pf.
* ÷	AC coupled input will accept voltage levels from 250 mv RMS to 2.5v RMS, limited to 9×10^8 volts/sec (about 1v RMS at 100 MHz sinewave). 5v RMS maximum input without damage to circuit.	50Ω nominal

SELECTABLE FREQUENCY RANGES

Direct Input

1 KHz Range	5 Hz to 1 KHz
10 KHz Range	50 Hz to 10 KHz
100 KHz Range	500 Hz to 100 KHz
1000 KHz Range	5 KHz to 1000 KHz

* ÷ 100 Input

100 KHz Range	1 MHz to 10 MHz
1000 KHz Range	1 MHz to 100 MHz

NULL RANGES

Full scale meter sensitivity is ±.01%, 0.1%, 1%, 10% and 100% of selected frequency range. Operates as a direct reading hertzmeter in 100%.

NOTE

Normally used in most sensitive position because of non-saturating null amplifier.

RESOLUTION

Null Meter: 0.0002% of range (1 minor division on mirror scale of null meter).
Transfermatic Switch: 0.001% of range (1 part in 100,000)

FREQUENCY ACCURACY

±0.01% of reading ±0.001% of range at constant temperature. Temperature coefficient ±0.0005% of range/^{o}C (calibrated at 25^{o}c).

TIME BASE STABILITY

1 MHz crystal, ±0.001% accuracy; temperature drift ±0.005% -30^{o}C to +90^{o}C. Crystal aging rate: 5 ppm for 30 days. Conforms with MIL-C-3098 Type CR18.

DIRECT READING HERTZMETER (100% Meter Sensitivity)

1 KHz, 10 KHz, 100 KHz, 1 MHz, 10 MHz,* and 100 MHz*full scale. Accuracy 3% of full scale.

RESPONSE

Response to step input: .01% of range in 3 sec., .001% of range in 8 sec.

DEVIATION RESPONSE

Null meter will respond to sinusoidal frequency deviation up to 0.5 Hz. Meter deflection is 3 db down at 0.5 Hz.

* Models 207 and 702 only

SECTION III
OPERATING INSTRUCTIONS

FUNCTION OF CONTROLS

IDENTIFICATION	FUNCTION
TRANSFERMATIC SWITCH	Used to divide down internal reference frequency to match the unknown input; provides readout of unknown input.
METER SENSITIVITY (% of RANGE)	Selects the null meter full scale sensitivities of ±0.01%*, ±0.1%, ±1%, ±10% or ±100% of range.
METER	Indicates approximate input when METER SENSITIVITY is set to 100% of RANGE and the difference between the unknown and internal reference when used as a null detector.
MECHANICAL ZERO CONTROL	Sets the meter to zero mechanically. This adjustment should be used only after the instrument is turned off.
RECORDER OUTPUT	An output, proportional to the null meter reading, for driving an external recorder.
FUSE	The fuse is a 1/2 amp slow-blow type for 115 VAC operation. If the instrument is converted for 230 VAC operation change the fuse to 1/4 amp slow-blow type.

* Not applicable to Models 201 and 202.

IDENTIFICATION	FUNCTION
+ and — terminals	Input for unknown voltage
Chassis ground terminals	Used for grounding (See common mode and grounding considerations)
FUNCTION	Provides AC line power to transformer in all positions except off; changes polarity of input terminals of all DIAL-AMATIC Voltmeters as standard functions and also provides special functions as follows: Connects AC converter to input for measurement of AC voltage (Models 202, 204 and 206). Connects frequency converter to input for measurement of frequency (Model 207 only). Applys battery supply voltages to voltmeter circuits of "B" models - 201B, 202B, 203B and 204B. *
RANGE	Selects the desired voltage range of 1, 10, 100, or 1000 volts. Positions decimal point for voltage readout dials.
ZERO ADJUST (Models 201, 202, 203, 204, 205, 206 and 207)	Provides compensation for minor drifts in the null amplifier. This should be adjusted only after the instrument has been on for at least one hour. When checking or adjusting for offsets, set controls as follows: + and — inputs shorted, TRANSFERMATIC switch .0000, RANGE at 1, and METER SENSITIVITY to 0.01%.

* AC power is applied to battery charging circuit whenever instrument is connected to AC line.

GENERAL

The DIALAMATIC Differential Voltmeters may be used to measure unknown DC voltages, (DC/AC on Models 202, 204 and 206). These instruments are also useful for monitoring voltage drift about a known voltage, or to adjust a voltage to a precise value. Suggested procedures for these operations are outlined in this section. For critical measurements, turn the instrument on and allow an hour warmup period. The instrument may be used immediately for less critical measurements.

Measurement of an Unknown Voltage

Preset controls as follows:

RANGE	1000 v
METER SENSITIVITY	100 %
FUNCTION	+
TRANSFERMATIC SWITCH	all zeros

1) Connect the unknown voltage to the + and – input terminals. If one side is grounded, connect it to the – terminal.

2) Set the RANGE switch to the lowest range that will permit on-scale meter deflection.

3) If meter deflection is to the right, the polarity of the input voltage is negative. Turn FUNCTION switch to negative.

4) Set readout dials to the approximate value displayed on the meter and note the position of the decimal point.

   NOTE: Because of the speed of operation of the TRANSFERMATIC switch, it is not necessary to perform this step unless desired.

5) Set meter sensitivity to any desired null sensitivity.

   NOTE: Because of the ease of operation of the TRANSFERMATIC switch, METER SENSITIVITY may be set directly to the most sensitive null position desired.

6) Start turning the dial at the left in the direction the meter needle should move towards zero. When the meter needle swings to the opposite side, the second dial is turned in the direction the meter needle should move. Follow this same process through the dials from left to right until a null is obtained.

7) When a null has been obtained at the desired sensitivity, the unknown voltage can be read directly from the readout dials.

Monitoring Voltage Drift About a Center Voltage

1) Set METER SENSITIVITY to 100%. Connect the unknown voltage to the + and − input terminals.

2) Set the proper RANGE. Set TRANSFERMATIC switch readout dials to the desired center voltage. The null meter indication should agree with the significant number indication on the readout dials.

3) Switch METER SENSITIVITY to 10%. Any deflection on the null meter now indicates the difference between the center voltage as set in and the actual voltage based on a full scale deflection of ±10% of the indicated voltage range.

4) If the difference voltage is less than 1% of range, indicated as less than one minor division deflection, the METER SENSITIVITY switch may be set to 1% still keeping the deflection on scale.

5) If the difference voltage is still less than one major division deflection, the sensitivity may again be increased. This process may be continued until the desired sensitivity is obtained.

6) When the final sensitivity is obtained, the null meter gives a dynamic indication of the difference voltage with full scale meter deflection being a percentage of the range as indicated by the METER SENSITIVITY switch.

Recording Voltage Drift

1) Perform the first three steps of Monitoring Voltage Drift About a Center Voltage.

2) Set METER SENSITIVITY to the most sensitive position within limits of expected drift.

3) Connect a recorder to the RECORDER OUTPUT terminals. Unbalance the TRANSFERMATIC switch to obtain full scale needle deflection in one direction then the other. Set recorder balance and gain to match the high and low full scale meter deflection. Reset readout dials to desired center voltage.

4) The recorder will now display voltage excursions with plus and minus full scale being a percentage of the desired voltage range.

NOTE: Recorder output voltage is approximately ±250 mv to ±300 mv for full scale deflection. Output impedance is 10 KΩ. A recorder with high (100K) input resistance should be used to prevent loading the null meter. If the leakage between the recorder input terminals and ground is less than 5,000 megohms the accuracy and common mode rejection of the voltmeter will be affected.

Adjusting an Unknown Voltage

1) Set METER SENSITIVITY to 100%. Connect the unknown voltage to the + and − input terminals.

2) Set proper RANGE. Set TRANSFERMATIC switch readout dials to the desired voltage.

3) Adjust the unknown voltage until the null meter needle deflection indicates the proper voltage based on full scale deflection of 100% of range.

4) Set the METER SENSITIVITY switch clockwise one position at a time and adjust the voltage source for less than one minor division of needle deflection on the null meter. Repeat this step until the desired null sensitivity is obtained.

DIRECT READING VOLTMETER OPERATION

The DIALAMATIC can be used as a direct reading voltmeter (±3% accuracy) with full scale sensitivities from 100* microvolts to 1000 volts. Set METER SENSITIVITY switch to the 100% position to operate the instrument as a direct reading voltmeter. The TRANSFERMATIC switch is not connected to the null amplifier when the METER SENSITIVITY switch is set to 100%. Four full scale ranges of 1, 10, 100, and 1000 volts are selectable with RANGE switch. Proceed with steps 1, 2, and 3 as stated in Measurement of an Unknown Voltage.

Additional direct reading voltmeter ranges from 100* microvolts to 100 millivolts full scale can be made available by using other positions of the METER SENSITIVITY switch. For this mode of operation set the TRANSFERMATIC switch readout dial to all zeros and the RANGE switch to the 1 volt position. Full scale ranges are available as follows:

METER SENSITIVITY	RANGE
0.01%‡	0-100 μv
0.1%	0-1000 μv
1%	0-10 mv
10%	0-100 mv

AC MEASUREMENTS (Models 202, 204 and 206)

The DC/AC Models have an a-c to d-c average responding converter calibrated to RMS voltage. For a-c measurements set the FUNCTION switch to AC. Proceed with the steps as outlined in Measurement of an Unknown Voltage omitting step 3.

* 1 mv for Models 201, 202
‡ Not applicable to 201, 202

COMMON MODE AND GROUNDING CONSIDERATIONS

A potential difference generally exists between different points on power systems ground. If the – input terminal of the voltmeter is connected to the chassis ground post at the voltmeter, the voltmeter will read the sum of the input signal and the potential difference along the power systems ground. This potential difference is known as a common mode voltage since it is common to both the + and – input lines. See Figure 3-1. The common mode voltage may be a-c as well as d-c. Under these conditions, the input should not be grounded at the voltmeter. Under certain conditions it may be desirable to ground the meter provided no common mode voltage exists. In order to maintain the high common mode rejection, the leakage resistance from the circuitry to chassis ground has to be extremely high to reduce the ground loop currents.

The leakage resistance from the power supplies to power ground form a high impedance bridge which is very hard to match (see Figure 3-2). Accuracy can suffer if the positive input of the amplifier is grounded and the source resistance is high. For source resistances of 100K or less, generally there is no loss in accuracy if the positive input of the amplifier is grounded. If it is necessary that this input be grounded, the meter should be zeroed.

Great care should be exercised when servicing the instrument so it does not become contaminated resulting in a lower leakage resistance. Leakage resistances to the chassis in the order of $10^{11}\Omega$ from the null amplifier common, and much higher values from the input attenuator, are necessary to insure the common mode performance. Since leakage resistance is dependent upon dampness, the common mode measurements should be made with a relative humidity below 70%. For high common mode voltages, the measurement should be made several minutes after application of the voltage since it takes time to charge stray capacities to ground through very high leakage resistances.

A 0.01 μf capacitor is connected from the – input terminal to chassis ground to reduce the effect of a-c leakage currents from the power transformer. It is possible under some conditions, such as when making common mode tests, for this capacitor to acquire a charge. Since in subsequent tests an error may exist until this capacitor discharges, the – input terminal should be shorted to chassis to provide a low impedance path for discharge.

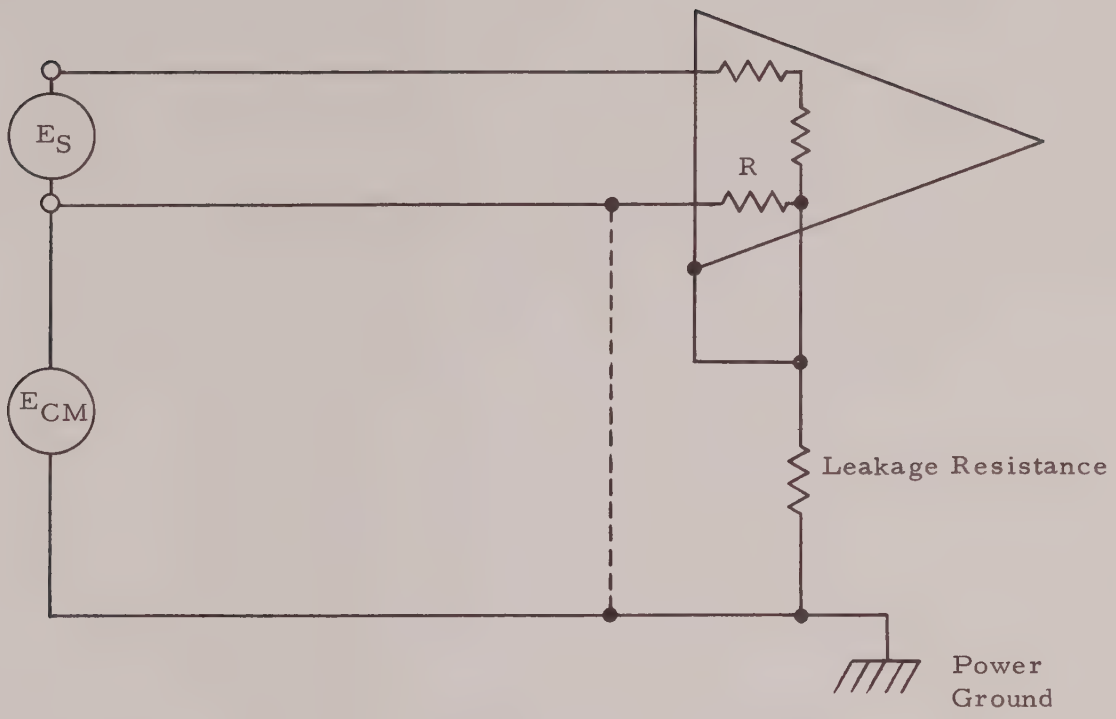


Figure 3-1.

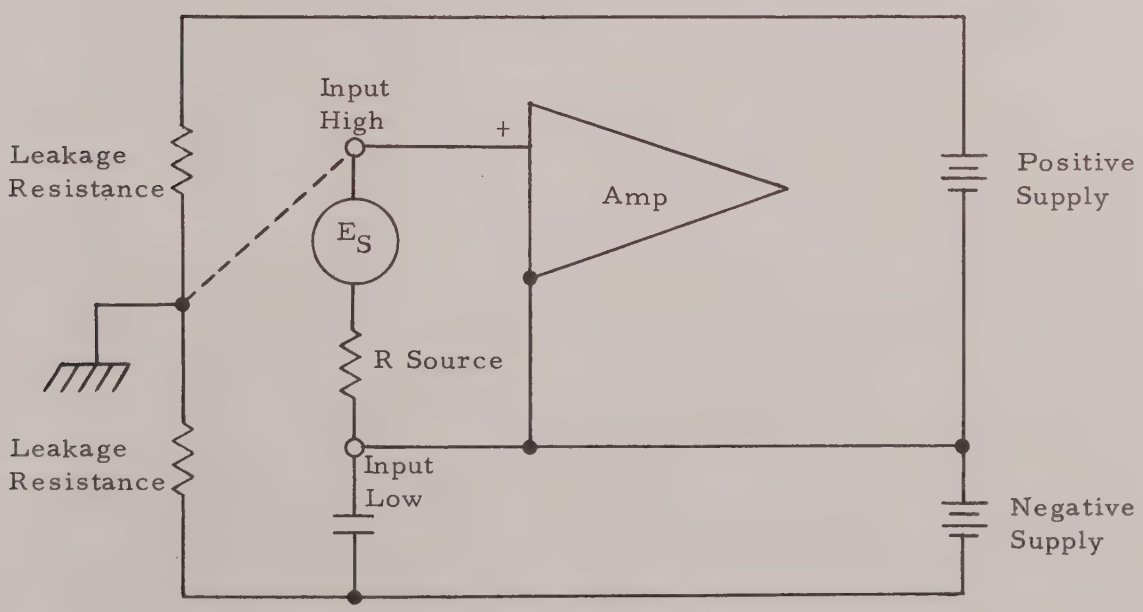


Figure 3-2.

IDENTIFICATION	FUNCTION
DIRECT INPUT	Input for unknown frequency; 5 Hz 1 MHz.
÷ 100 INPUT (Models 207 and 702 only)	Input for unknown frequency greater than 1 MHz. When using the — 100 input the scale factor is 10 MHz with the RANGE switch at 100 and 100 MHz with the RANGE switch at 1000.
RANGE	Selects the desired frequency range of 1 KHz, 10 KHz, 100 KHz, or 1000 KHz. NOTE: When using the ÷ 100 input the 100 KHz and 1000 KHz ranges are read as 10 MHz and 100 MHz respectively by mentally moving the decimal displayed two places to the right.
ZERO ADJUST	Provides compensation for minor drifts in the null amplifier. This should be adjusted only after the instrument has been on for at least one hour. When checking or adjusting for offsets, set TRANSFERMATIC switch at .0000; RANGE at 1 KHz and METER SENSITIVITY to 0.01%.
FAST-SLOW (Optional on Models 207, 701 and 702)	Provided to damp the response of the hertzmeter for closed loop voltage controlled frequency generator operation. Switch should normally be in the FAST position.
POWER (Models 701 and 702 only)	Provides AC power to transformer primary.

GENERAL

The Model 207, 701 and 702 Hertzmeters may be used to measure the frequency of a signal which is completely unknown, to monitor the frequency drift of a signal about a known center frequency, or to adjust the frequency of a signal to a precise value. The suggested procedure for these operations are outlined in this section. For critical measurements, the instrument should be given an initial one hour warmup period. For less critical measurements, however, the instrument may be used immediately.

Measurement of an Unknown Frequency

MODEL 207, 701 and 702 HERTZMETERS

Preset controls as follows:

RANGE	1000 KHz
METER SENSITIVITY	100%
TRANSFERMATIC SWITCH	all zeros

1) Connect the BNC cable from the DIRECT input connector to the signal source being measured. Set the RANGE switch to the lowest range that will permit on-scale meter deflection.

2) Set readout dials to the approximate value displayed on the meter and note the position of the decimal point.

   NOTE: Because of the speed of operation of the TRANSFERMATIC switch, it is not necessary to perform this step unless desired.

3) Set meter sensitivity to any desired null sensitivity.

   NOTE: Because of the ease of operation of the TRANSFERMATIC switch, METER SENSITIVITY may be set directly to most sensitive null position desired.

4) Start turning the dial at the left in the direction the meter needle should move towards zero. When the meter needle swings to the opposite side the second dial is turned in the direction the meter needle should move. Follow this same process through the dials from left to right until a null is obtained.

5) When a null has been obtained at the desired sensitivity, the unknown frequency can then be read from the readout dials in KHz.

MODELS 207 and 702:

Preset controls as follows:

RANGE	1000 KHz
METER SENSITIVITY	100%
TRANSFERMATIC SWITCH	all zeros

1) Connect a BNC cable from the ÷100 input to the signal source being measured.

2) Note the null meter reading. If it indicates more than full scale, the signal frequency is above the range of the frequency meter. If the needle deflection is between one major division and full scale, proceed to Step 4. If it reads less than one major division (10% deflection), rotate the range switch counterclockwise one position to 100 KHz. If the needle deflection is still less than one major division, return the range switch to the full clockwise position and proceed to Step 3.

3) Connect the BNC cable from the DIRECT input connector to the signal source being measured. Set the RANGE switch to the lowest range that will permit on-scale meter deflection.

4) Set readout dials to the approximate value displayed on the meter and note the position of the decimal point.

   NOTE: Because of the speed of operation of the TRANSFERMATIC switch, it is not necessary to perform this step unless desired.

5) Set meter sensitivity to any desired null sensitivity.

   NOTE: Because of the ease of operation of the TRANSFERMATIC switch, METER SENSITIVITY may be set directly to most sensitive null position desired.

6) Start turning the dial at the left in the direction the meter needle should move towards zero. When the meter needle swings to the opposite side the second dial is turned in the direction the meter needle should move. Follow this same process through the dials from left to right until a null is obtained.

7) When a null has been obtained at the desired sensitivity, the unknown voltage can then be read from the readout dials in KHz. (The readout is 100 times indication if the ÷100 input is being used.)

Monitoring Frequency Drift About a Center Frequency

1) Set METER SENSITIVITY to 100%. Connect the unknown to the DIRECT INPUT or ÷100 if input is greater than 1 MHz.

2) Set the proper RANGE. Set TRANSFERMATIC switch readout dials to the desired center voltage. The null meter indication should agree with the significant number indication on the readout dials.

3) Switch METER SENSITIVITY to 10%. Any deflection on the null meter indicates the difference between the center frequency as set in and the actual frequency based on a full scale deflection of ±10% of the indicated frequency range.

4) If the difference frequency is less than 1% of range, indicated as less than one minor division deflection, the METER SENSITIVITY switch may be set to 1% still keeping the deflection on scale.

5) If the difference frequency is still less than one major division deflection, the sensitivity may again be increased. This process may be continued until the desired sensitivity is obtained.

6) When the final sensitivity is obtained the null meter gives a dynamic indication of the difference frequency with full scale meter deflection being a percentage of the range as indicated by the METER SENSITIVITY switch.

Recording Frequency Drift

1) Perform the first three steps of Monitoring Frequency Drift About a Center Voltage.

2) Set METER SENSITIVITY to the most sensitive position within limits of expected drift.

3) Connect a recorder to the RECORDER OUTPUT terminals. Do not ground the recorder input low terminal to earth. Unbalance the TRANSFERMATIC switch to obtain full scale needle deflection in one direction then the other. Set recorder balance and gain to match the high and low full scale meter deflection. Reset readout dials to desired center frequency.

4) The recorder will now display changes in frequency with plus and minus full scale being a percentage of the desired voltage range.

NOTE: Recorder output voltage is approximately ±250 mv to ±300 mv for full scale deflection. Output impedance is 10 Kohm. A recorder with high (100K) input resistance should be used so as not to load the null meter. If the leakage between the recorder input terminals and ground is less than 5,000 megohms the accuracy and common mode rejection of the frequency meter will be affected.

Adjusting the Frequency of a Signal

1) Set METER SENSITIVITY to 100%. Connect the unknown to the DIRECT INPUT or ÷100 if the input is greater than 1 MHz.

2) Set proper RANGE. Set TRANSFERMATIC switch readout dials to the desired frequency.

3) Adjust the unknown frequency until the null meter deflection indicates the proper frequency based on full scale deflection of 100% of range.

4) Set the METER SENSITIVITY switch clockwise one position at a time and adjust the frequency source for one minor division of needle deflection on the null meter. Repeat this step until the desired null sensitivity is obtained.

DIRECT READING HERTZMETER OPERATION

The Models 207, 701 and 702 can be used as a direct reading hertameter (±3% accuracy) with full scale sensitivities from 1 KHz to 1 MHz (100 MHz, 207 & 702 only). Set the METER SENSITIVITY switch to the 100% position to operate the instrument as a direct reading hertzmeter. The TRANSFER-MATIC switch is not connected to the null amplifier when the METER SENSITIVITY switch is set to 100%. Four full scale ranges of 1, 10, 100, and 1000 KHz* are selectable with the RANGE switch.

Two additional direct reading hertzmeter ranges of 100 Hz and 10 Hz full scale can be made available by using 10% and 1% positions, respectively, of the METER SENSITIVITY switch. It is necessary to have the TRANS-FERMATIC switch readout dials to all zeros and the RANGE switch to the 1 KHz position for this mode of operation. Do not attempt to use the instrument as a direct reading hertzmeter in the .1% or .01% position because these ranges are below the frequency response (5 Hz) of the hertzmeter.

CLOSED LOOP FREQUENCY CONTROL

The Models 207, 701 and 702 , as an optional feature, can be used to improve frequency stability of voltage controlled generators such as WAVETEK Models 111 through 116. Stability of less than 20 ppm/hr or 50 ppm/24 hr can be obtained using this method. Hertzmeters with this option have a switch located on the rear of the instrument labeled FAST-SLOW as shown in Figure 3-2a.

The principal of operation is to use the hertzmeter to monitor the frequency output and feed back a correction voltage from the recorder output to the VCG input. In order to operate properly in this mode, additional circuitry must be used to damp the hertzmeter deviation response. This is done by setting the switch located on the rear of the instrument to SLOW.

The setup procedure as shown in Figure 3-1a is as follows:

1) Connect the output (high side only) of the generator to the direct input of the hertzmeter.

2) Connect the hertzmeter positive recorder output to the common VCG input and the negative recorder output to the high side of the VCG input.

3) Set METER SENSITIVITY to 0.1%.

NOTE: Do not attempt to use the instrument in the 0.01% position as the increased gain will cause unstable operation.

4) Set the RANGE switch and TRANSFERMATIC readout dials to the desired operating frequency.

5) Adjust frequency of generator until a null is indicated in the hertzmeter. The hertzmeter will now control the frequency stability of the generator.

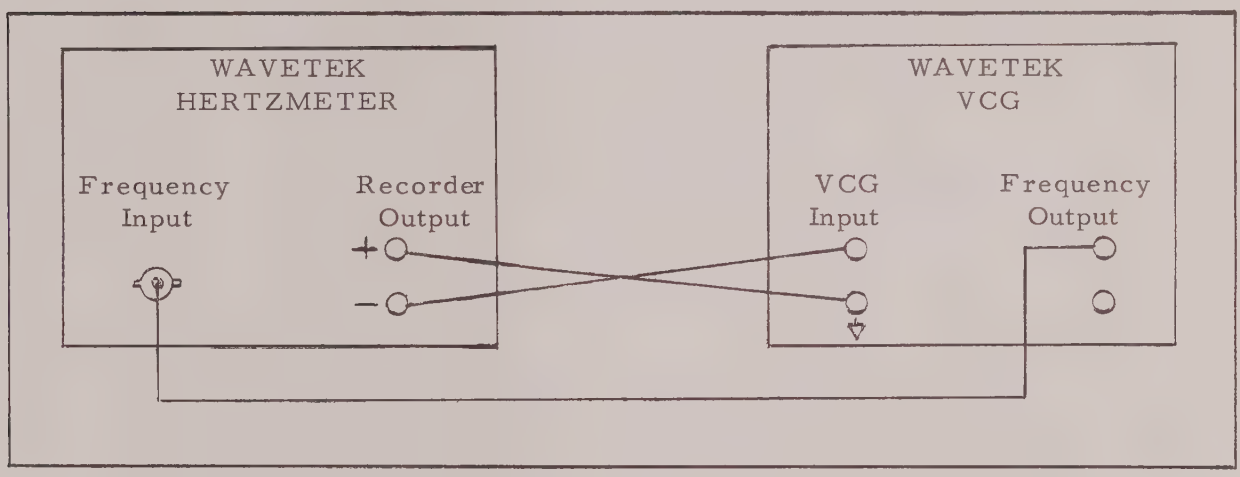


Figure 3-1a

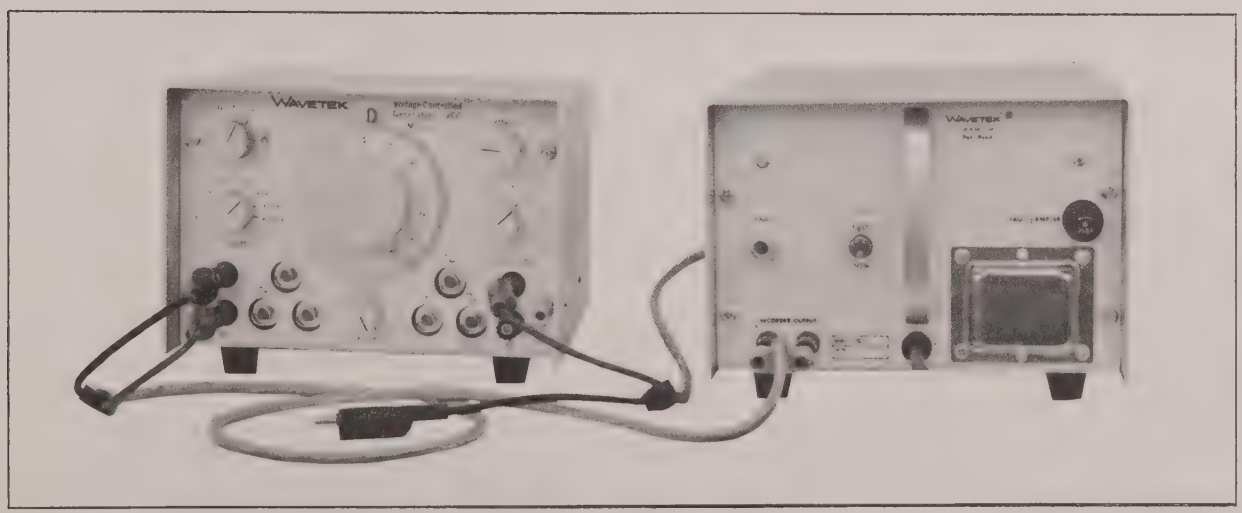


Figure 3-2a

SECTION IV
THEORY OF OPERATION

GENERAL

A simple block diagram of the differential voltmeter mode is shown in Figure 4-1. The differential mode consists of a series circuit of the unknown input voltage (E_S), an accurately adjustable bucking voltage (E_B), and a null amplifier driving a meter to read the difference between E_S and E_B. The polarity of E_S is reversible so that when the magnitude of E_B is adjusted equal to E_S, they will subtract and the amplifier will indicate a null. Under these conditions of balance or null, the current flowing across the input circuit will be zero and the input impedance will approach infinity. It is evident that if other leakage paths exist, the input impedance will be limited. Extreme care has been exercised at the factory to keep the voltmeter clean and extra isolation has been provided to insure the high input impedance.

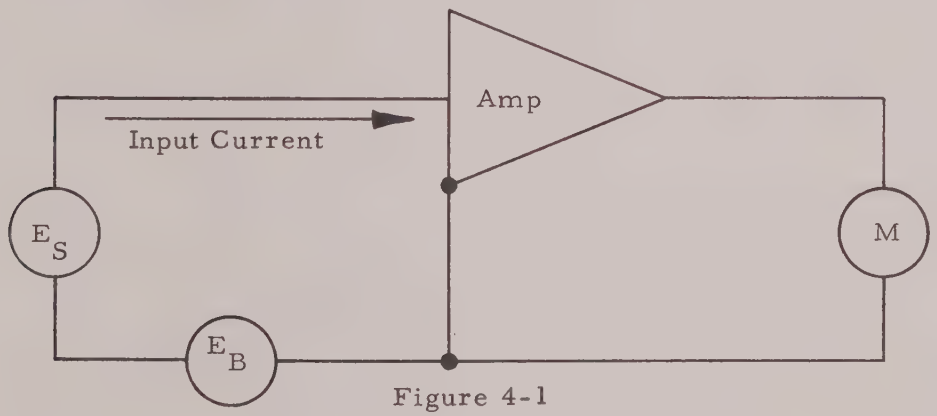


Figure 4-1

Figure 4-2 is a detailed block diagram of the differential mode which illustrates the signal flow and the basic block expansion for additional capabilities.

INPUT ATTENUATOR (Models 201, 202, 203, 204 and 207)

An input attenuator, R119 and R120 on the range board schematic, is used to scale down input voltages which are greater than 10 volts. This is necessary since the highest reference voltage used is 10 volts. A reference voltage of one volt is used for the 1 and 100 volt ranges. The scaled down input voltage is then balanced out by the bucking voltage as before. The accuracy is now dependent upon the accuracy of the input attenuator. The attenuator consists of three 3.3 MegΩ and one 100KΩ wirewound resistors for stability and one 10 KΩ potentiometer, R104, for adjustment to an exact 100 to 1 attenuation. The input impedance is limited to 10 MegΩ for input voltages greater than 10 volts.

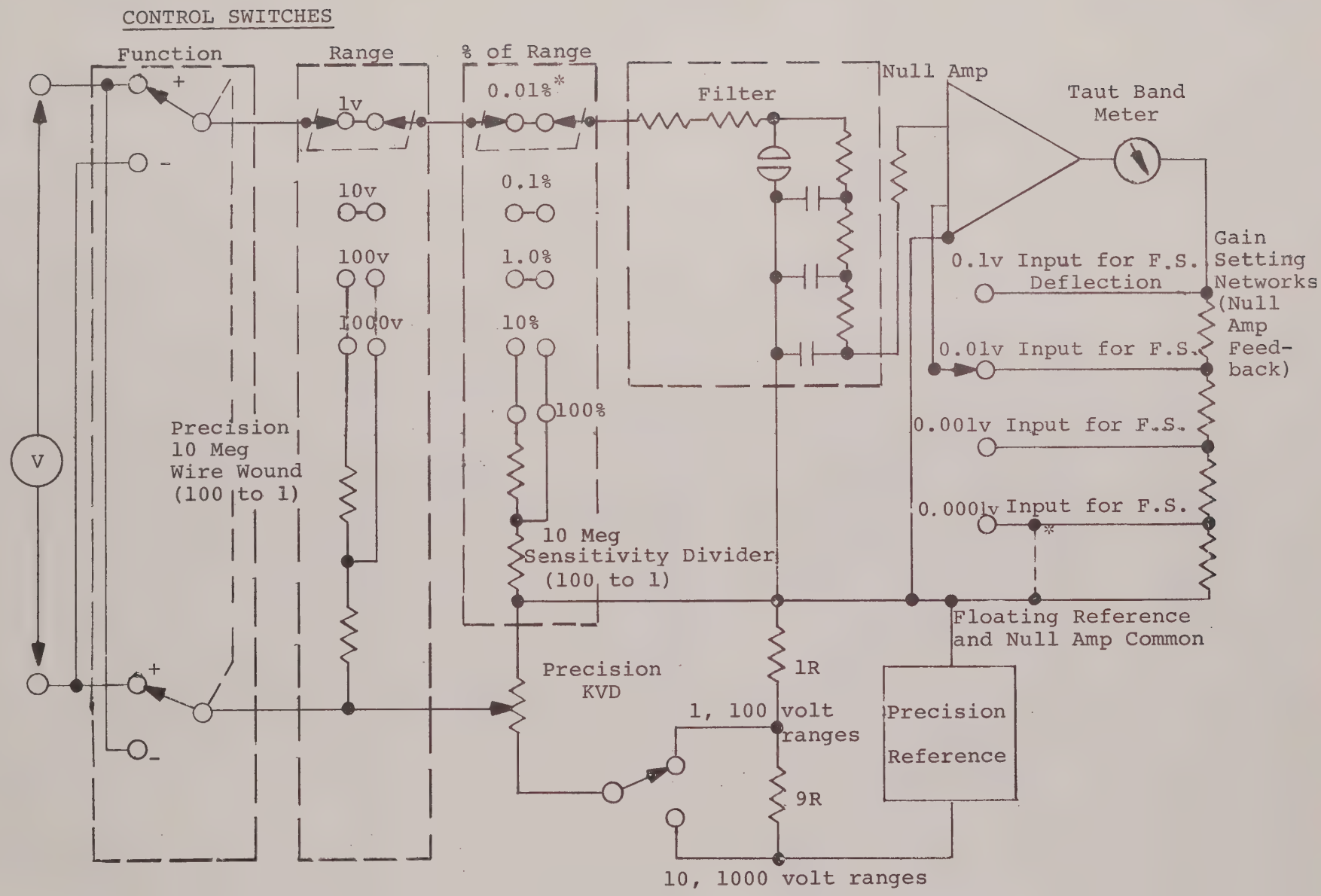


Figure 4-2.

*0.01% of Range and 0.0001 Input for F.S. Not Used on Models 201 and 202.

The null amplifier of the basic block diagram, Figure 4-1, has been expanded in Figure 4-2 to include a 100 to 1 sensitivity divider, an input filter, the potentiometric null amplifier, and the feedback gain setting networks.

SENSITIVITY DIVIDER

The 100 to 1 sensitivity divider is composed of metal film resistors. At a perfect null, the divider will have zero volts across its and so will not affect the accuracy of the indicated reading. For a null meter indication other than zero, the deflection accuracy is dependent upon the accuracy of this divider. However, metal film resistor accuracies are consistent with the accuracy of the best meter movements available.

INPUT FILTER AND LIMITER

The input filter is a three-pole RC low pass filter designed to give 60 db attenuation at 50 Hz. The filtering is desirable since large AC input voltages could saturate the null amplifier. Two 150 KΩ, 2 watt resistors and the neon tube form an input voltage limiter. This enables continuous application of 1000 volts d-c to the meter, even when the meter is set on the 1 volt range.

NULL AMPLIFIER

The null amplifier is composed of a dual transistorized chopper followed by a d-c coupled differential carrier amplifier with common mode feedback, a full wave demodulator for a d-c to a-c to d-c gain of approximately 200. This is followed by a post amplifier. The combination of the d-c coupled carrier and the output limiting of the post amplifier give the null amplifier its very rapid overload recovery.

FEEDBACK NETWORK

The feedback network provides for a null amplifier gain of 0.1, 0.01, 0.001 and 0.0001* volts for full scale meter deflection. The amplifier output current goes through the meter and to the attenuator resistors. This feedback establishes a precise current through the meter and makes the deflection independent of the meter resistance wich is desirable since the meter responds to current rather than voltage.

Table 4-1 summarizes the switching logic and signal conditioning.

As indicated by the block diagram (Figure 4-2), the three most important factors with regard to accuracy are 1) the precision of the input attenuator, 2) the accuracy of the Kelvin-Varley Divider (KVD), and 3) the accuracy of the reference voltage. Wirewound resistors (±5 ppm/^{o}c) are used in all three. The reference utilizes two temperature matched zener diodes. A positive TC is matched with a similar negative TC to assure a near zero TC for the pair.

*Not Applicable to Models 201 and 202.

CONTROL SWITCHES			Sensitivity Divider	Input Atten.	Voltage Across KVD	Null Amp Gain (input voltage for full scale deflection)
Function	Range Volts	% of Range				
DC + or -	1	0.01*	-----	-----	1	0.0001
	1	0.1	-----	-----	1	0.001
	1	1	-----	-----	1	0.010
	1	10	X.01	-----	1	0.001
	10	0.01*	-----	-----	10	0.001
	10	0.1	-----	-----	10	0.010
	10	1	-----	-----	10	0.100
	10	10	X.01	-----	10	0.010
	100	0.01*	-----	X.01	1	0.0001
	100	0.1	-----	X.01	1	0.001
	100	1	-----	X.01	1	0.010
	100	10	X.01	X.01	1	0.001
	1000	0.01*	-----	X.01	10	0.001
	1000	0.1	-----	X.01	10	0.010
	1000	1	-----	X.01	10	0.100
	1000	10	X.01	X.01	10	0.010
100% (Direct Reading Volt-meter)	1	----	X.01	-----	--	0.010
	10	----	X.01	-----	--	0.100
	100	----	X.01	X.01	--	0.010
	1000	----	X.01	X.01	--	0.100

*Not Applicable to Models 201 and 202

Table 4-1.

PRECISION REFERENCE SUPPLY

Figure 4-3 shows the basic block diagram of the reference supply; refer also to the null amplifier board schematic. The amplifier consists of a low drift differential pair, Q17 and Q18, followed by an output stage, Q15 and Q16, and a series regulator, Q14. CR1 and CR2, in series, provide the reference voltage.

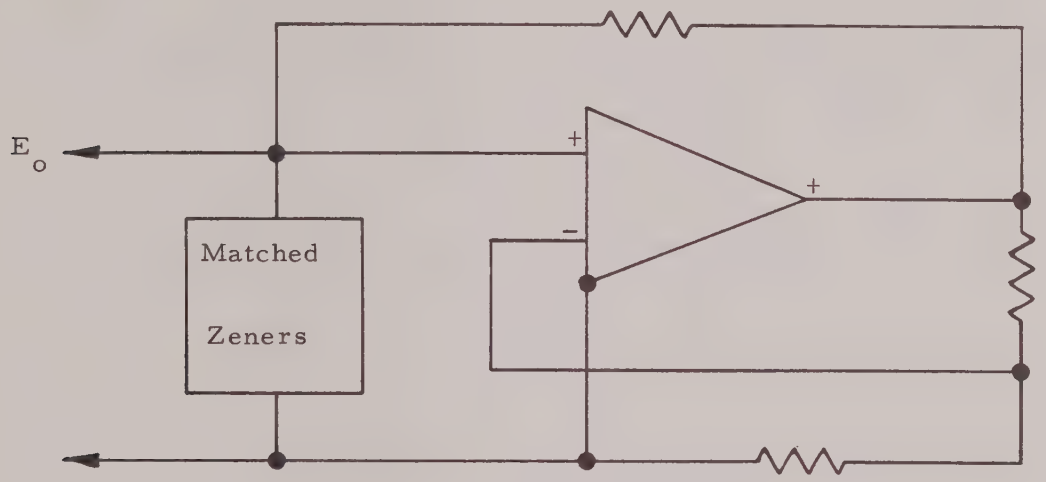


Figure 4-3

This combination provides a stable and precise current for the zener diodes and, therefore, forms an accurate reference when the load across the zener is constant.

NULL AMPLIFIER.

Refer to the null amplifier board schematic. The null amplifier is composed of a mos-fet chopper followed by a d-c coupled carrier amplifier with common mode feedback, Q21 through Q26, and a full wave demodulator for a d-c to a-c to d-c gain of approximately 200. This is followed by an integrated circuit post amplifier with a gain of approximately 1000. The input signal is fed directly to the carrier amplifier, while the feedback from the post amplifier goes to the N-channel mos-fet switch, Q19.

Chopper drive for the mos-fets and demodulator is obtained from IC1 through buffer amplifiers Q5 and Q6 at a frequency of 165 Hz. When the two mos-fets are turned on together, the feedback signal from the post amplifier IC2 is coupled to the carrier amplifier. The feedback signal level overrides the input signal because of the low impedance drive of the post amplifier output coupled through Q19. When Q19 and Q20 are turned off, the carrier amplifier sees the input signal. No signal actually passes through the P-channel mos-fet, Q20. Its function is to neutralize the switching spikes and provide thermal balance for Q19.

Q9 and Q10 compose full wave demodulator circuit. These transistors are on alternately, driven by Q6, and sum the carrier amplifier output through R21 and R23. The signal is then applied to the post amplifier, IC2.

An output limiting circuit composed of Q12 and Q13 limits the output voltage swing to approximately ±600 mv. The combination of the d-c coupled carrier amplifier and the output limiting of the post amplifier give the null amplifier very rapid overload recovery.

Regulated +6 volts is provided by a regulator, Q1 and Q2. Reference voltage for this supply is obtained from the -17 volt regulator described under Precision Reference Supply. Q3 and Q4 are the -6 volt regulator with reference to the +6 volt supply through R5. Current for the -6 volt supply is obtained from the -17 volt regulator.

FEEDBACK NETWORK

The feedback network provides for a null amplifier gain of 0.1, 0.01 and 0.001 and 0.0001* volts for full scale meter deflection. The amplifier output current goes through the meter and to the attenuator resistors. This feedback establishes a precise current through the meter and makes the deflection independent of the meter resistance which is desirable since the meter responds to current rather than voltage. R123 is switched out to compensate for the loading of the attenuator on the 100 and 1000 volt ranges for the 0.01%*, 0.1% and 1% null sensitivities.

DIRECT READING VOLTMETER MODE

Figure 4-4a is a detail block diagram of the direct reading voltmeter mode. The meter reads an attenuated input voltage and the deflection is proportional to the input voltage. Four full scale ranges of 1, 10, 100, and 1000 volts are available. The input impedance is 10 megs for all ranges (See Table 4-1).

RECORDER OUTPUT

Full scale output of the voltmeter at the recorder output terminals on the rear panel is a nominal 300 millivolts. The output is isolated by two 4.7K resistors, R67 and R68, located on the d-c board. The recorder input should be well isolated so there will be no degradation in common mode rejection and no offsets due to circulating ground currents.

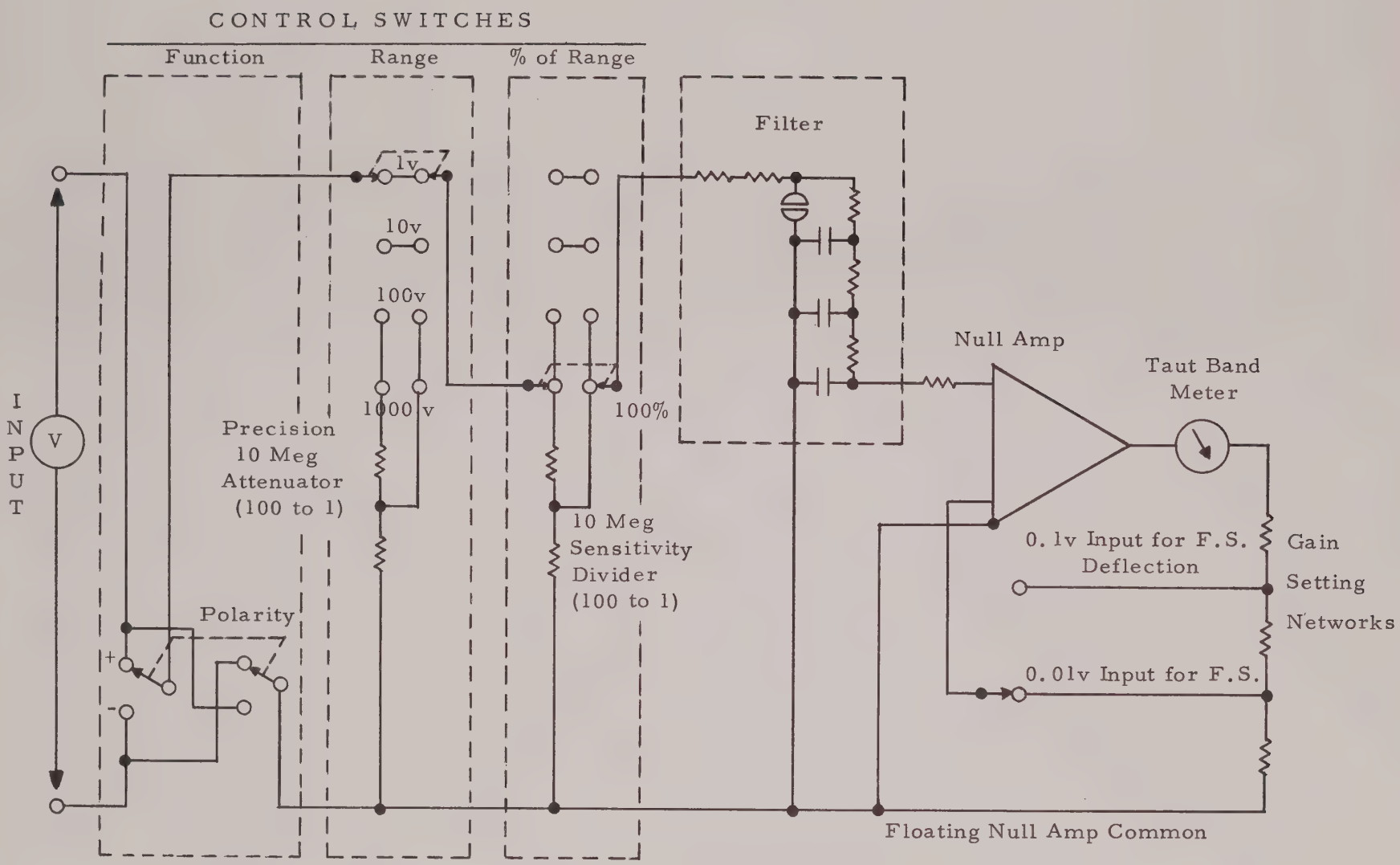

CONTROL SWITCHES
Function
Range
% of Range
Filter
1v
10v
100v
1000 v
100%
INPUT
V
Precision
10 Meg
Attenuator
(100 to 1)
10 Meg
Sensitivity
Divider
(100 to 1)
Polarity
+
-
Null Amp
Taut Band
Meter
0.1v Input for F.S.
Deflection
Gain
Setting
Networks
0.01v Input for F.S.
Floating Null Amp Common

Figure 4-4a

HERTZMETER MODE

The WAVETEK Model 207 Hertzmeter operates basically similar to a common automotive tachometer; that is, a rectilinear pulse waveform is generated. The pulses have a fixed height and width so that the area under the curve is constant. As shown in Figure 4-1a, when the average value of this waveform is taken by filtering, the resulting DC level is proportional to the input frequency. A null amplifier compares this voltage with a precision resistance divider to obtain accurate frequency readout. Figure 4-2a is a detailed block diagram of the hertzmeter.

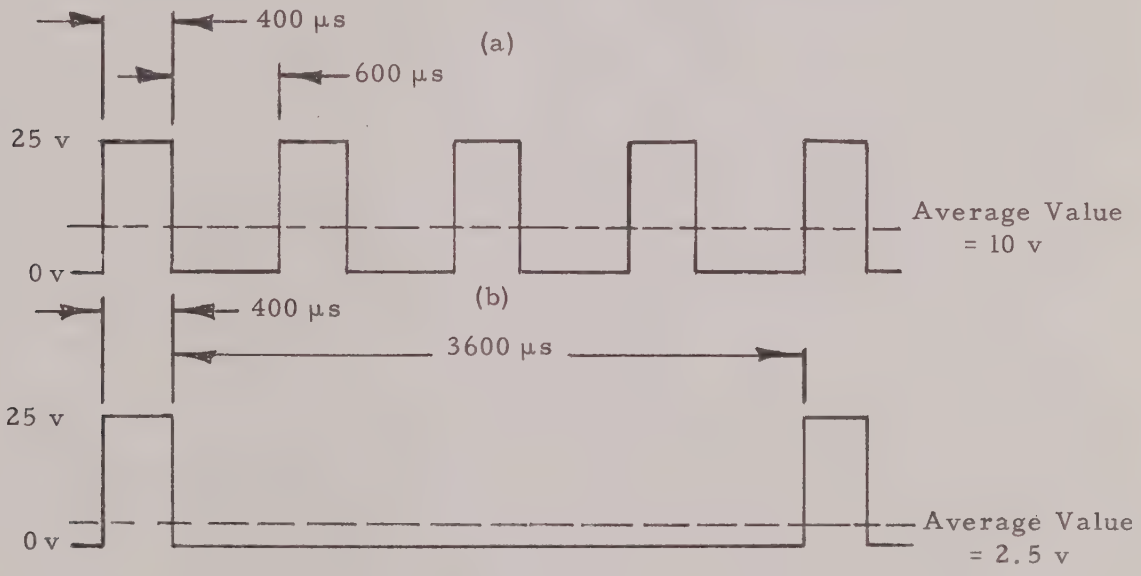


Figure 4-1a

INPUT SIGNAL CONDITIONING

Direct Input: (Refer to Fig. 4-1a and Frequency to Ratio Converter Schematic)

The direct input connector feeds a buffer amplifier, Q4 and Q5, which has high input impedance and low output impedance. Input limiting from +12 v to -10 v is accomplished by CR1 and CR2 so that junction voltage ratings on devices in the circuit won't be exceeded by large signals. The output from Q5 is capacity coupled to a grounded forward biased diode, CR3. This network allows the Schmitt trigger, IC27, to detect the crossings of a voltage level near positive peaks of the input.

IC27 is an integrated circuit operational amplifier connected so that it operates in a bistable manner, commonly called a Schmitt trigger. When the input goes

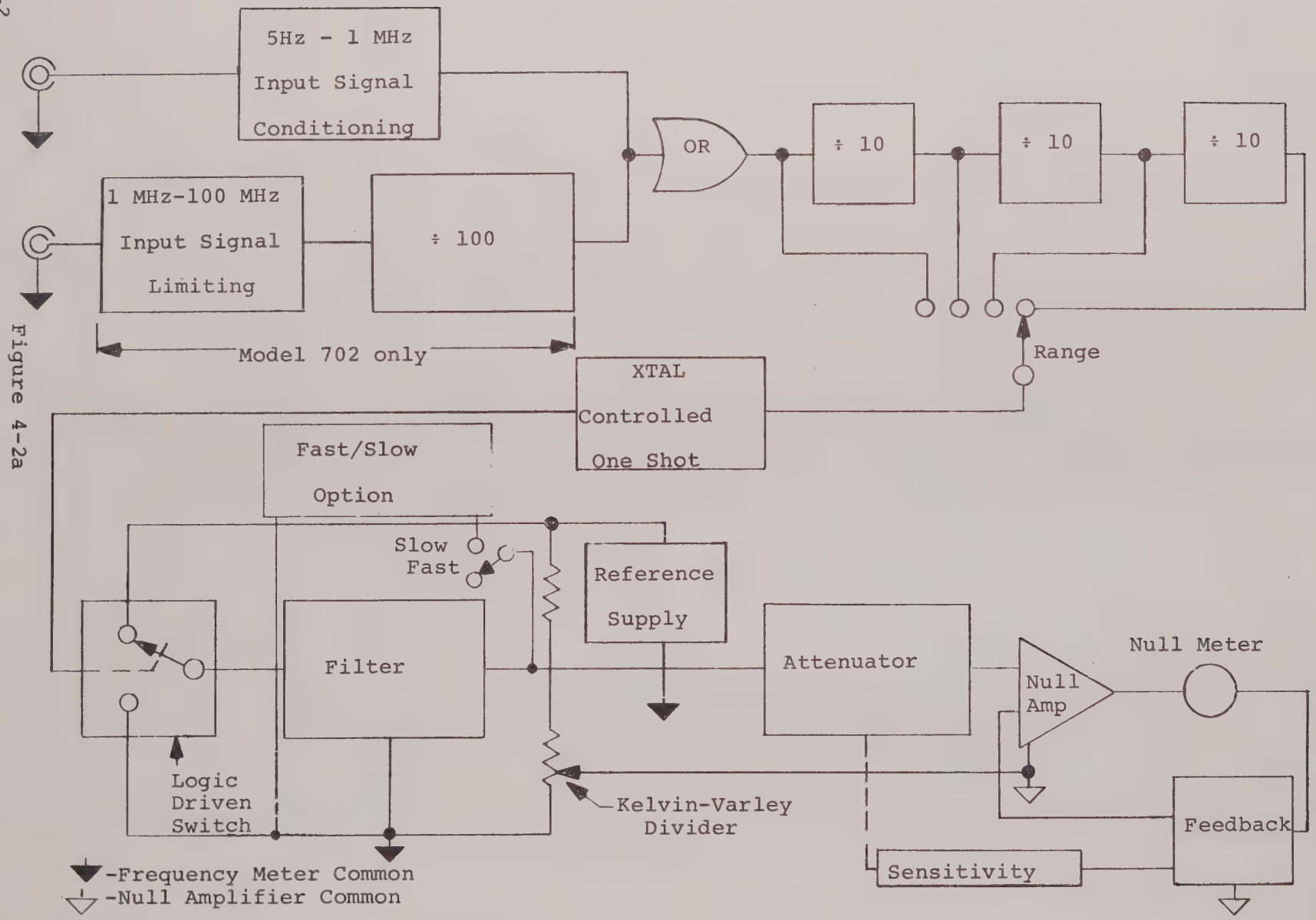

5Hz - 1 MHz
Input Signal
Conditioning
1 MHz-100 MHz
Input Signal
Limiting
÷ 100
Model 702 only
OR
÷ 10
÷ 10
÷ 10
Range
XTAL
Controlled
One Shot
Fast/Slow
Option
Slow
Fast
Reference
Supply
Filter
Attenuator
Null
Amp
Null Meter
Logic
Driven
Switch
Kelvin-Varley
Divider
Feedback
Sensitivity
-Frequency Meter Common
-Null Amplifier Common

Figure 4-2a

positive and exceeds a voltage level set by R14, the output goes positive and is clamped by CR6 and CR7 and turns Q8 off. When the input goes negative and exceeds a voltage in the negative direction about 100 mv more negative than the voltage set by R14, the output goes negative and turns Q8 on. The negative voltage swing is limited by the emitter-base junction of Q8. This switching action is coupled through Q8 to Q10. CR4 and CR6 are temperature compensation and protection circuits respectively. R14 is adjusted so that the upper voltage crossing level is just below the 600 mv level set by CR3. An "OR" circuit consisting of Q10 and Q11 will accept an input from Q8 or the "divide by 100" circuit (Models 207 and 702 only). The output of the "OR" circuit is sent to the RANGE switch and a series of modulo ten counters used for additional ranging.

Divide By 100 Input (Models 207 and 702): (Refer to the Range Extender Schematic)

The range extender is designed to accept signals from 1 MHz to 100 MHz. Input impedance is 50Ω for purposes of terminating a 50Ω coaxial cable. Q1 and Q2 form a Schmitt trigger which responds to crossings of the average value axis. Because of this, it is responsive only to reasonably time symmetrical signals. IC1 serves as a buffer amplifier between the Schmitt Trigger and the counter circuit. A "divide by 20 counter" circuit is formed by IC2 through IC6. Q3 and Q4 provide an interface circuit between IC6 and IC7 because of the difference in required logic levels. An additional divide by 5 counter consisting of IC7 through IC9, provides a total frequency division of 100. The output of this circuit is fed to one-half of the "OR" circuit, Q9, on the Frequency to Ratio Schematic.

FREQUENCY RANGING: (Refer to Figure 4-2a)

The basic frequency range at output of the "OR" circuit from the direct input is 1 KHz. When the RANGE switch is in the "1" position, the signal is fed directly to the one-shot gating circuit, IC25, through the buffer amplifier Q1 and Q2. Additional ranging up to 1 MHz is obtained through three "divide by ten" counters. The three modulo 10 counters consist of IC1 through IC4, IC5 through IC8, and IC9 through IC12 on the Frequency to Ratio Converter Schematic respectively.

CRYSTAL CONTROLLED ONE-SHOT: (Refer to the Frequency to Ratio Converter Schematic and Figure 4-2a)

To generate a rectilinear pulse with a fixed width, as shown in Figure 4-1, a one-shot multivibrator is usually used. Series 700 Hertzmeters use a crystal oscillator and resistor-transistor logic elements to replace the conventional one-shot for greater pulse width precision. A signal from a 1 MHz crystal oscillator, IC13, is fed to a modulo 800 counting circuit, IC14 through IC24. When this circuit is gated on, one-half cycle length at the output, IC24, is 400 μsec. The first flip-flop in the counting circuit, IC14, is also used as a gate. This gate is activated by the gate driver, IC25.

The gate driver is released by a signal corresponding to the input signal via buffer amplifier, Q1 and Q2. Feedback from the counter output, IC24, will cause the gate driver to change states, thus, on command of the input signal, the counting circuit is released, counts to 800 and locks itself up. The output of the counter circuit, which is a 400 μsec. wide pulse, is fed to Q13.

COMPARISON BRIDGE

The comparison bridge consists of a logic driven switch, filter, and reference supply as shown in Figure 4-2a and the Frequency to Ratio Converter Schematic. Two mos-fet (enhancement-mode) switches, Q14 and Q15, are alternately on, driven by the crystal controlled one-shot through Q13. Quiescently, Q14 is turned on by Q12 connecting the filter, R31 and C10 to ground. When the crystal controlled one shot turns Q13 on, Q14 turns off and Q15 is turned on connecting the filter to the +25 v reference for 400 μsec. out of each input cycle. In this way, the duty cycle of the switches contains the input frequency information. R29 is used to offset the difference of the "ON" resistance of the two mos-fets. DC output of the filter is a voltage proportional to input frequency with 10 volts representing full scale. The 25 volt reference is also applied to the Kelvin-Varley Divider, divided down to 10 v by R26, R27, R32 and R33. The output of the Kelvin-Varley Divider is a DC level which contains the information of that part of the full range which is set into the front panel switch dials. The filter output is fed to the high side of a null amplifier. When the meter sensitivity switch is in the 100% (direct reading meter) position, the low side of the null amplifier is connected to common so the meter reads the filter output with respect to common. At this sensitivity, the null amplifier gain is set so that the full scale input to the amplifier is 10 v. When the sensitivity switch is in the more sensitive positions, the low side of the null amplifier is connected to the output of the Kelvin-Varley Divider and the gain is set to an appropriate value for that sensitivity. In these positions, the null amplifier compares the output of the filter to the output of the Kelvin-Varley Divider so that the two DC levels may be brought to the desired degree of equality.

NULL CIRCUITRY

Feedback Network

The feedback network provides a null amplifier gain of 0.1, 0.01, or 0.001 volts for full scale meter deflection. The amplifier output current goes through the meter and attenuator resistors, as shown on the Range Board Schematic. This feedback establishes a precise current through the meter and makes the deflection independent of meter resistance which is desirable since the meter responds to current rather than voltage. Additional METER SENSITIVITY ranging is accomplished by inserting a 100:1 attenuator in the front of the null amplifier.

SECTION V
MAINTENANCE

GENERAL

In the event of improper operation of the voltmeter, the trouble area can usually be isolated to one of several specific circuits. This can be done by the use of the equipment schematic diagrams and suitable test equipment. To facilitate troubleshooting, the following information is provided. However, before proceeding with detailed troubleshooting, be sure that the trouble cannot be corrected by a calibration adjustment.

PERFORMANCE CHECK

Connect a wide range, precision power supply, such as a Kintel Model 326, or equivalent, to the input terminals. Set the voltmeter as shown in Table 5-1 to check operation as a direct reading voltmeter. Set the voltmeter as shown in Table 5-2 to check operation as a differential voltmeter.

KVD SETTING	RANGE	METER SENSITIVITY	INPUT VOLTAGE	METER READING
.0000	1v	100%	±1v	±Full Scale
.0000	1v	10%	±0.1v	±Full Scale
.0000	1v	1%	±10mv	±Full Scale
.0000	1v	0.1%	±1mv	±Full Scale
.0000	1v	0.01%*	±100μv	±Full Scale
0.000	10v	100%	±10v	±Full Scale
0.000	10v	10%	±1v	±Full Scale
0.000	10v	1%	±0.1v	±Full Scale
0.000	10v	0.1%	±10mv	±Full Scale
0.000	10v	0.01%*	±1mv	±Full Scale
00.00	100v	100%	±100v	±Full Scale
00.00	100v	10%	±10v	±Full Scale
00.00	100v	1%	±1v	±Full Scale
00.00	100v	0.1%	±0.1v	±Full Scale
00.00	100v	0.01%*	±10mv	±Full Scale
000.0	1000v	100%	±1000v	±Full Scale
000.0	1000v	10%	±100v	±Full Scale
000.0	1000v	1%	±10v	±Full Scale
000.0	1000v	0.1%	±1v	±Full Scale
000.0	1000v	0.01%*	±0.1v	±Full Scale

*Not Applicable to Models 201 and 202

Table 5-1

KVD SETTING	RANGE	METER SENSITIVITY	INPUT VOLTAGE	METER READING
.5000	1v	10%	±0.500v	Null
.5000	1v	1%	±0.500v	Null
.5000	1v	0.1%	±0.500v	Null
.5000	1v	0.01%*	±0.500v	Null
5.000	10v	10%	±5.000v	Null
5.000	10v	1%	±5.000v	Null
5.000	10v	0.1%	±5.000v	Null
5.000	10v	0.01%*	±5.000v	Null
50.00	100v	10%	±50.00v	Null
50.00	100v	1%	±50.00v	Null
50.00	100v	0.1%	±50.00v	Null
50.00	100v	0.01%*	±50.00v	Null
500.0	1000v	10%	±500.0v	Null
500.0	1000v	1%	±500.0v	Null
500.0	1000v	0.1%	±500.0v	Null
500.0	1000v	0.01%*	±500.0v	Null

*Not Applicable to Model 201 and 202

TABLE 5-2

Input Divider

The input divider, R104, R119, and R120 shown in the range board, is inserted at all times when the voltmeter is in the 100 or 1000 volt ranges. These resistors will affect both meter deflection accuracy and KVD readout accuracy on these ranges only. Check the input divider circuit resistors by means of a precision resistance bridge. If this is not available, the 3.3 megohm resistors may be checked by applying a voltage across the HIGH and LOW input terminals with the RANGE switch set to 100 or 1000 volts. Measure the voltage drop across each resistor with a suitable voltmeter.

NOTE: Since these resistors are relatively high in value, consider meter loading. Accuracy check will be limited to the accuracy of the voltmeter used.

Null Sensitivity Divider

The null sensitivity divider, R101, R102, and R106, shown on the range board schematic, is inserted at all times when the meter SENSITIVITY switch is in the 10% or 100% positions on all voltage ranges. An error in this divider circuit will cause an improper reading off null at these sensitivities. It will not affect voltage readout accuracy at null.

POWER SUPPLIES

Generally, the first step in troubleshooting is to check the power supply voltages. Be sure the instrument is plugged in, turned on, and the line fuse is intact. Four separate DC voltages, measured with respect to null amplifier common (terminal No. 1 or No. 4), should be present on the null amplifier board. An additional DC voltage, measured with respect to AC Converter common (terminal No. 2), should be present on AC Converter board.*

NULL AMPLIFIER

VOLTAGE	LOCATION	REMARKS
-17v ±170 mv	Case of Q14	less than 1 mv noise and ripple
-10v	Terminal 12	see Calibration procedure, 10 volt Range for adjustment method.
+6.2 ±0.2v	Terminal 9	less than 5 mv noise and ripple, 1 mv chopper signal
-6.3 ±0.2v	Terminal 8	less than 5 mv noise and ripple, 3 mv chopper signal
AC CONVERTER*		
+12v ±0.6v	junction of R215 and R254	less than 2mv ripple

TABLE 5-3

Reference Supply

Since the null amplifier power supplies are derived from the reference regulator (-17 volt supply), any trouble in the reference supply will likely result in improper operation of the null amplifier. A trouble in the 10 volt reference (-17 volt supply) will show up as an error in voltage readings on the readout dials. Meter deviation with respect to the METER SENSITIVITY setting, with the readout dials at 0000, will not be affected. The resistive divider, R114, R121, and R122 is switched in only when the RANGE switch is in the 1 or 100 volt range. In these two ranges 1 volt should appear across the KVD, and 10 volts should appear across the KVD in the 10 and 1000 volt ranges. If readout error occurs on only the 1 and 100 volt ranges check R114, R121, and R122.

*Models 202, 204 and 206 Only

MODEL 207 HERTZMETER MODE

In the event of improper operation of the hertzmeter, the trouble area can usually be isolated to one of several specific circuits. This can be done by the use of equipment schematic diagrams and suitable test equipment. To facilitate troubleshooting, the following information is given. However, before proceeding with detailed troubleshooting be sure that the trouble cannot be corrected by a calibration adjustment.

POWER SUPPLIES

Generally, the first step in troubleshooting is to check the power supply voltages. Be sure the instrument is plugged in, turned on and the line fuse is intact. Three separate DC voltages, measured with respect to the frequency to ratio converter common, should be present. These voltages are available on the power supply or converter board.

1. +25 v ±2 v:	less than 2 mv ripple and noise
2. +3.6 v ±360 mv:	less than 100 mv ripple and noise
3. -10 v:	less than 1 v ripple unregulated

Three separate DC voltages, referred to null amplifier common, should be present on the Null Amplifier Board.

1. -17 v ±170 mv:	less than 1 mv noise and ripple
2. +6.2v ±.2 v:	less than 5 mv noise and ripple, 3 mv chopper signal
3. -6.3v±.2 v:	less than 5 mv noise and ripple, 3 mv chopper signal

NOTE: When the METER SENSITIVITY switch is in the 100% position, both converter and null amplifier commons are connected together. In all other positions the null amplifier common is connected to the arm of the Kelvin-Varley divider.

RANGE EXTENDER BOARD

100 Input Signal Conditioning

On application of a 1 volt peak to peak signal of 1 MHz to the ÷100 input, a rectilinear waveform of equal frequency should appear at TP6. The positive state should be about -0.6 v and a negative state of -1.5 volts.

It is suggested that this test be done at the low frequency end of the band (1 MHz) as the other end of the band (100 MHz) requires an oscilloscope with good high frequency response for an accurate reading. This block of circuitry consists of Q1, Q2 and IC1, with their associated circuitry on the range extender schematic diagram.

Range Extender ÷100 Circuitry

IC2 and IC3 each divide the input signal frequency by two. IC4 through IC6 is a divide-by-five block. Q3 and Q4 together make a logic interface between two types of micrologic elements. IC7 through IC9 is the final divide-by-five block. The frequency at the output of this circuit should be exactly one hundred times lower than the signal frequency. Logic levels at the base of Q4 are approximately -0.6 volts and -1.5 volts with respect to common. At the collector of Q3 and the output of the range extender the logic levels are +1 and zero volts.

FREQUENCY TO RATIO CONVERTER

Direct Input Signal Conditioning

On application of a moderate amplitude signal between 5 Hz and 1 MHz to the direct input TP4, pin 7 of IC27, should show a rectilinear waveform of equal frequency about 1.5 volts peak to peak centered about ground. When the signal is removed, the level at TP4 should return to the positive state of approximately 800 mv. This may take several seconds.

Logical OR Gate

The input signal to the range switch is the output of the OR gate, Q10 and Q11. The signal at this point should be rectilinear about 1.5 volts peak to peak. The frequency should be equal to the input signal frequency if the signal is put on the direct input or one hundred times lower if the signal is put in on the divider 100 input.

Crystal Oscillator

IC13 on the frequency to ratio converter schematic with its associated circuitry is a crystal controller oscillator. TP2 is its output and should have a 1 MHz signal at all times when the instrument is on. IC26 is a modulo two counting flip-flop which also runs continuously. Its output at TP3 is a 500 KHz signal for calibrating purposes only and has no other function.

Crystal Divider and Gating Logic

IC14 through IC25 on the frequency to ratio converter schematic makes up this circuit. Its output is at TP5, pin 7 IC24, and functions as a "one shot" which is triggered by the signal from the buffer amplifier, Q1 and Q2. When pin 6 of IC25 goes high, pin 7 goes low. This negative pulse is coupled to pins 1 and 3 of IC14 allowing the flip-flop to divide the 1 MHz

signal by two and pass the signal to IC15. The whole string of flip-flops, IC14 through IC24, is now released to count off eight hundred cycles of the crystal oscillator. At the end of four hundred cycles from the oscillator pin 7 of IC24 goes positive turning on Q13. This positive level has no affect on IC25. The output remains in the positive state for the second four hundred cycles of the group of eight hundred cycles. At this time, the negative transition at pin 2 of IC25 causes pin 7 to go high which in turn inhibits IC14. IC25 will not change states again until it is activated by an input signal on pin 6. If trouble is experienced in this circuit, it may be necessary to open the jumper provided on the board located near the crystal. Connect the terminal closest to the crystal to common. The lock-up flip-flop IC25 can no longer control IC14. This procedure allows the whole modulo eight hundred circuit to run free of control by the input signal. It is then possible to locate the trouble spot by finding the point where the signal path stops functioning.

Bridge Switches

The normal output of the crystal controlled "one-shot" is a clean positive going rectilinear pulse four hundred μsec. in width. This pulse is fed to the switch drive, Q13, which has a constant current load, Q12. The collector of Q13 drives the gates of the bridge switches, Q14 and Q15, which are a complimentary pair of mos-fets. These switches form one side of the comparison bridge and are connected so that when one is off the other is on. The ratio of the on time of Q15 to the total time per cycle times 25 volts is a measure of the frequency of the input signal. For example, a 1 KHz input signal will produce 400 μsec. positive going pulses 600 μsec. apart. This will give a total time of 1 ms which corresponds to 1 KHz. Therefore, the output at terminal No. 8 of the frequency to ratio converter would be:

$$\frac{400\ \mu\text{sec.}}{1\ \text{ms}} \times 25\ \text{v} = 10\ \text{v}$$

The potentiometer, R29, and associated trim resistors is a network for equalizing the effective on resistance of the two switches. This equalization affects the linearity of the measurement. Refer to the calibration procedure for the adjustment of R29.

Full Range Calibrate - R33

R33, located on the frequency to ratio converter board, is used to adjust the 25 volt to 10 volt divider for the KVD. Small variations in the 25 volt supply will not affect the readout because these variations will be felt across both the switching mos-fet, Q15, and the Kelvin-Varley divider. However, if the divider ratio to the Kelvin-Varley divider is incorrect, there will be an error in frequency readout. Refer to the calibration procedure for proper adjustment of R33.

SECTION VI
CALIBRATION

D-C CALIBRATION

EQUIPMENT REQUIRED

1. Voltmeter, 0.01% accuracy (WAVETEK Model 201 or equivalent).
2. Oscilloscope, Tektronix 422 or equivalent.
3. DC Standard, Kintel Model 326 or equivalent.

To perform calibration of the Null Amplifier Board, remove the two left side rails and swing the board out for easy access to calibration controls. If trouble occurs with any step of the procedure, refer to the MAINTENANCE Section for further information.

NULL AMPLIFIER

There are thirteen wires connected to the Null Amplifier Board. Most of these connection points are labeled on the etched side of the board.

Set front panel controls as follows:

FUNCTION	+
RANGE	1 v
METER SENSITIVITY	0.01%
DIALAMATIC SWITCHES	0000

Power Supplies

Connect a voltmeter between common, terminal No. 1 or No. 4, and the respective supply listed below. Check or adjust for the proper voltage. Connect an oscilloscope between common and the voltage listed. Check for specified ripple.

Test Point	Voltage Supply	Tolerance	Adjustment	Ripple (p-p)
Q14 case	-17 v	±170 mv	R35	1mv @ line freq.
Terminal No. 9	+6 v	+6.2v ±3%	------	5mv @ line freq. 3mv choper spikes
Terminal No. 8	-6 v	-6.3v ±3%	------	5mv @ line freq. 3mv chopper spikes

Reference Current

Connect a voltmeter across R71 (453Ω). Adjust Reference Current, R40, for 3.85 volts ±50 mv.

DC Balance

Connect a voltmeter from common to the collectors of Q23 and Q24 respectively. Adjust DC Balance, R57, for equal collector voltage within ±100 mv. (Approximate voltage -3v)

Null Amplifier Neutralization

Connect an oscilloscope between null amplifier common and the emitter of Q10. Adjust Neutralization, R16, for less than 50 mv spikes. Recheck DC Balance.

Short Circuit Zero

NOTE: Before adjusting the short circuit zero control, the mechanical zero of the meter must be checked, and the front panel Zero adjust set to mid-range. See Section III, Function of Controls for procedures. Be sure the DIALAMATIC switch is set to all zeros.

Connect the input cable to the input terminals and short the cable clips together. If there is meter deflection, adjust Short Circuit Zero, R24 for zero on the meter.

Open Circuit Zero

Remove the input cable. If there is a meter deflection, adjust Open Circuit Zero, R53, for zero on the meter.

RANGE CALIBRATION

Set the front panel controls as follows:

FUNCTION	+
RANGE	10 v
METER SENSITIVITY	0.01%
DIALAMATIC SWITCHES	9.500

10 Volt Range

Connect the input cable to the DC Standard and adjust the standard for 9.500 volts. Adjust the 10 volt Range Adjustment, R43, located on the null amplifier board, for a null.

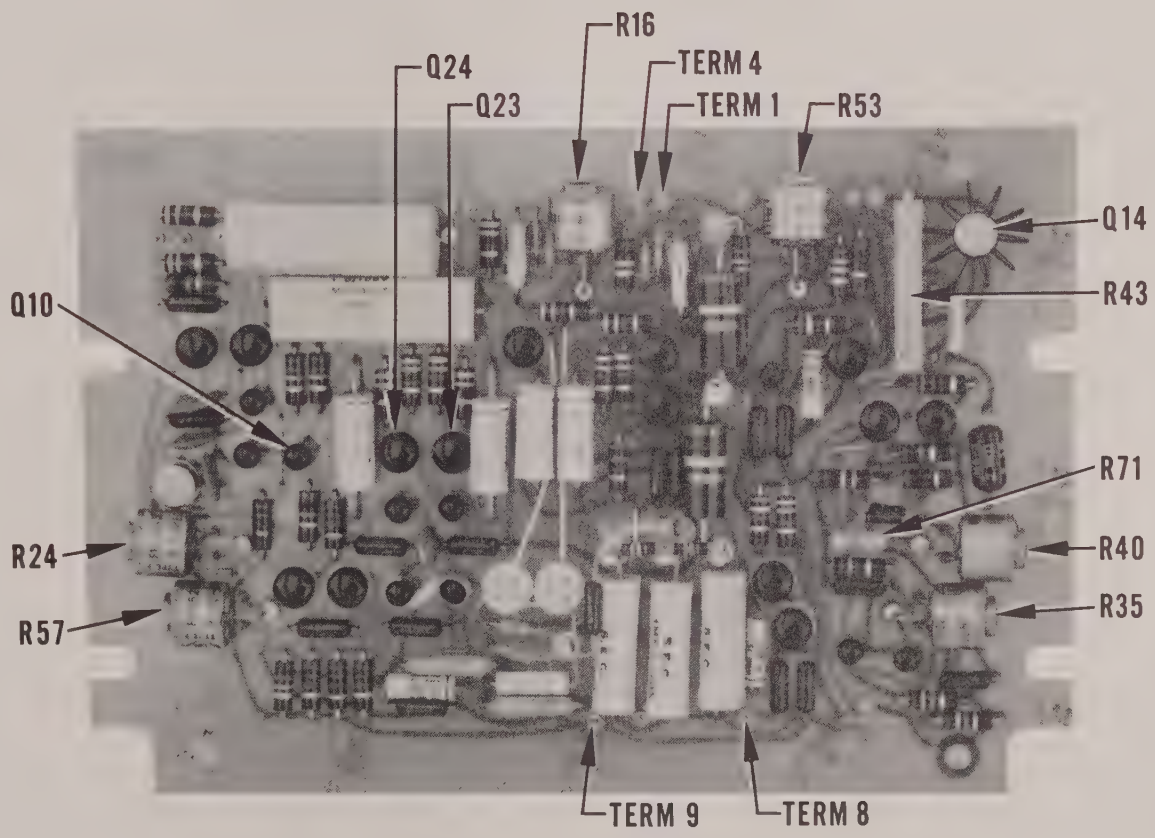


Figure 6-1
Null Amplifier Board
Maintenance/Calibration Locations

1 Volt Range

Change the DC Standard output to 0.95000 volts. Set the RANGE switch to the 1 volt range. Adjust 1 Volt Range Adjustment, R114, located on the Range board, for a null.

100 Volt Range

Change the DC Standard output to 95.000 volts. Set the RANGE switch to the 100 volt range. Adjust 100 Volt Range Adjustment, R104, located on the Range board, for a null.

1000 Volt Range

Change the DC Standard output to 950.000 volts. Set the RANGE switch to the 1000 volt range. Check for a null. (Due to the accuracy of the range resistors, there need not be an adjustment for the 1000 volt range.)

Full Scale Adjust

Set the front panel controls as follows:

FUNCTION	+
RANGE	1 v
METER SENSITIVITY	0.1%
DIALAMATIC SWITCHES	0000
INPUT CABLE	Shorted

Turn the least significant decade (pot) on the DIALAMATIC switch to "10." The meter should read full scale. Adjust Full Scale Deflection Adjustment, R111, for full scale deflection.

DIRECT READING VOLTMETER

Set the front panel controls as follows:

FUNCTION	+
RANGE	As required
METER SENSITIVITY	100%
DIALAMATIC SWITCHES	Any setting, DIALAMATIC is not connected to the meter when the Meter Sensitivity switch is in the 100% position.

Check the 1v, 10v, 100v, and 1000v ranges with the DC Standard (set to .9v, 9v, 90v and 900v respectively. The meter should read 0.9 ±1.5 minor divisions (3% of full scale) on each range.

KVD Linearity Check

Once the DC section has been calibrated, the linearity of the Kelvin-Varley Divider may be checked. For proper linearity the meter should indicate zero within ±0.01% of dial reading, ±0.001% of range, ±10μv for each DC Standard voltage input.

Set the front panel controls as follows:

FUNCTION	+
RANGE	10 v
METER SENSITIVITY	0.1%
DIALAMATIC SWITCHES	0.000

Connect the DC Standard to the high and low input terminals. Rotate each DIALAMATIC decade switch to positions 1 through 9. At each switch position adjust the DC Standard voltage to produce zero meter deflection.

Examples of allowable errors are shown below.

READOUT DIAL	0.010	0.300	8.00
±0.01% of reading ±0.001% of range ±10μv	±1μv ±100μv ±10μv	±30μv ±100μv ±10μv	±800μv ±100μv ±10μv
Error Allowed	±111μv	±140μv	±910μv

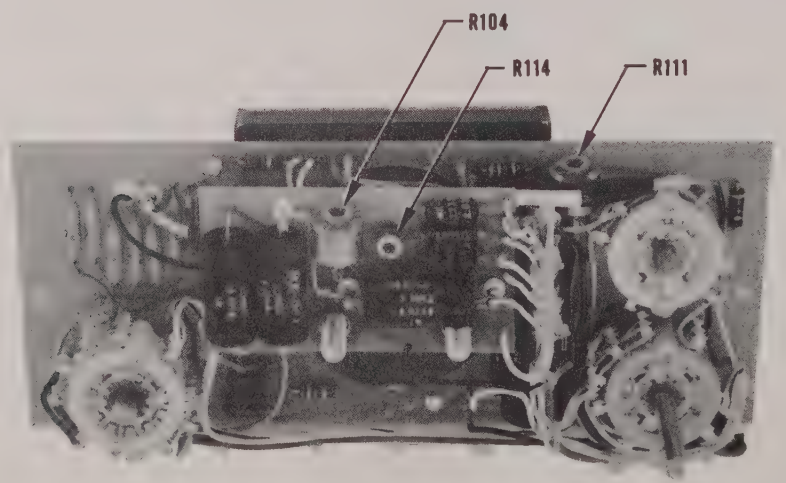


Figure 6-2

FREQUENCY CONVERTER

EQUIPMENT REQUIRED

1 Precision frequency signal source with divide-by-2 capabilities, or adjustable period; accuracy - at least ±0.001%

1 Oscilloscope, Tektronix 454 or equivalent

1 Variable Amplitude Signal Generator, WAVETEK Model 111 or equivalent

1 Voltmeter 0.01% accuracy; WAVETEK Model 201 or equivalent

1 VHF Oscillator with a variable output greater than 100 MHz

Power Supplies

Connect a Voltmeter between common, terminal No. 6, and the respective supply listed below. Check or adjust for the proper voltage. Connect an oscilloscope between common and the voltage listed. Check for specified ripple.

Test Point	Voltage Supply	Tolerance	Adjustment	Ripple
TP1 or top of R2	+3.6 v	±360 mv	R13 (Power Supply Bd.	100 mv at line freq. (ripple and noise)
Terminal No. 7	+25 v	±2 v	----	2 mv at line freq. (ripple and noise)
Terminal No. 5	-10 v	±1 v	----	1 v at line freq.

Signal Threshold Level

Set the front panel controls as follows:

POWER	ON
RANGE	1 MHz
METER SENSITIVITY	100%
DIALAMATIC SWITCHES	All at zero

Connect an oscilloscope between frequency common and TP 4 (junction of R17 and IC27 pin 7). Connect the DIRECT INPUT to the variable amplitude frequency generator. Set the generator to approximately 10 KHz and adjust the output to approximately 10 volts. The oscilloscope should display two states, one approximately +700 mv and the other approximately -700 mv., occurring at the generator frequency. Set the frequency amplitude to 200 mv peak-to-peak. Set R14 to the extreme clockwise limit. Slowly adjust R14 counterclockwise to the point where the display reappears on the oscilloscope. Remove the DIRECT INPUT signal and the display should change to a steady state, approximately +700 mv level, within 10 seconds. If not, repeat adjustment of R14.

Linearity Calibration

Set front panel controls as follows:

POWER	ON
RANGE	As required
METER SENSITIVITY	10%
DIALAMATIC SWITCHES	As required

Connect the DIRECT INPUT to the precision frequency source. Set the frequency source to a frequency that is near the top of one of the ranges on the meter RANGE switch; for example, 950 KHz. Set amplitude of frequency source to any value between 250 mv and 600 v peak-to-peak.

Set RANGE switch to appropriate range for the Reference Frequency. Set READOUT DIALS to the Reference Frequency. Observe null meter needle deflection.

Adjust R33 for zero deflection. Change precision frequency source to one-half the Reference Frequency; for example, 475 KHz. Set the READOUT DIALS to this frequency. Observe null meter needle deflection.

Adjust R29 for a meter deflection to the opposite polarity which is 1.5 times the indicated deflection. For example, if indicated deflection is -.40, adjust R29 for deflection of +.60. Change the frequency source to the Reference Frequency; for example, 950 KHz. Set METER SENSITIVITY to 1%. Readjust R33 for zero deflection. Change the frequency source to one-half the reference frequency; for example, 475 KHz. If deflection is greater than full scale, decrease METER SENSITIVITY. Repeat alternate adjustment of R29 and R33 until the indicated deflections at the selected frequencies are less than full scale with METER SENSITIVITY at 0.01%. Readjust R33 until meter deflection is less than 2% (1 minor division). Wait 20 seconds for possible drift.

Change precision frequency source to the one-half frequency previously selected. Set the READOUT DIALS to this frequency. Observe null meter deflection. Readjust R29 until meter deflection is less than 2% (1 minor division). Wait 20 seconds for possible drift.

Repeat alternate frequency inputs and adjustments, with 20 second pauses between a new input and its corresponding adjustment, until a final adjustment is made to R33 that does not require an adjustment of R29 when the one-half frequency is connected to the DIRECT INPUT.

Change the precision frequency source to the Reference Frequency. Meter deflection should be less than 2% (1 minor division). Wait 20 seconds for possible drift.

The meter is now calibrated to an accuracy of ±0.01% of reading ±0.001% of range at constant temperature.

In the absence of a suitable source for calibration, internal TP 2 at 1 MHz and TP 3 at 500 KHz can be used for calibration to an accuracy of 0.1% of range. See Self Check Test Procedure.

Full Scale Deflection of Meter

Set the front panel controls as follows:

POWER	ON
RANGE	1 MHz
METER SENSITIVITY	100%
DIALAMATIC SWITCHES	Any setting

Connect the DIRECT INPUT to a 1 MHz signal greater than the Signal Threshold Level. Adjust R128 located on Range Board for full scale deflection.

Range Extender (Models 207 and 702 only)

NOTE: The ÷100 INPUT will accept voltage levels from 250 mv RMS to 2.5 v RMS. Input impedance is 50Ω nominal.

No calibration adjustments are necessary on the range extender board. Check the measurement accuracy as follows.

Connect a VHF frequency source to the ÷100 INPUT. Set frequency to 1 MHz and amplitude to 250 mv RMS. Set RANGE switch to 100 KHz. Set METER SENSITIVITY to 0.01%. Adjust Dialamatic switches to obtain null. Observe Readout Dials.

Repeat procedure at 10 MHz. Repeat procedure at 100 MHz, except set RANGE switch to 1000 KHz.

Set frequency source to 50 MHz and amplitude to approximately 2.5 v RMS. Set RANGE switch accordingly. Adjust dialamatic switches to obtain null. Observe Readout Dials.
Set frequency source to 100 MHz and amplitude to approximately 1.0 v RMS. Set RANGE switch to 1000 KHz. Adjust Dialamatic switches to obtain null. Observe Readout Dials.

Measurement accuracy should be ±0.01% of reading ±0.001% of range. See Test Procedures section for example.

DIRECT READING HERTZMETER

Set the front panel controls as follows:

POWER	ON
RANGE	As required
METER SENSITIVITY	100%
DIALAMATIC SWITCHES	Any setting

Connect the precision frequency source to the DIRECT INPUT. Check the 1 KHz, 10 KHz, 100 KHz, and 1000 KHz ranges with the precision frequency source set to 0.9 KHz, 9 KHz, 90 KHz, and 900 KHz respectively. The meter should read 0.9 ±1.5 minor divisions (3% of full scale) on each range.

(Models 207 and 702 only).

Connect the precision frequency source or VHF oscillator to the ÷100 INPUT. Set the RANGE switch to 100 KHz. Set the frequency source to 9 MHz. Observe the null meter indication. Set the RANGE switch to 1000 KHz. Set the frequency source to 90 MHz. Observe the null meter indication. The meter should read 0.9 ±1.5 minor divisions (3% of full scale) on each range.

SELF CHECK

All Hertzmeters have the capability of self frequency check if no standard frequency is available. Connecting a lead from TP2 or TP3 to the direct input, as shown in Fig. 2- 1, will provide a 1 MHz and 500 KHz signal respectively. The accuracy of the internal crystal reference is 0.001%. Adding this to the accuracy of the instrument figured previously, the self check difference on the 1 MHz range would be as follows:

	TP2 1 MHz	TP3 500 KHz
0.01% of reading +0.001% of selected range +0.001% standard error	100 Hz 10 Hz 10 Hz	50 Hz 10 Hz 5 Hz
Total allowable error	120 Hz	65 Hz

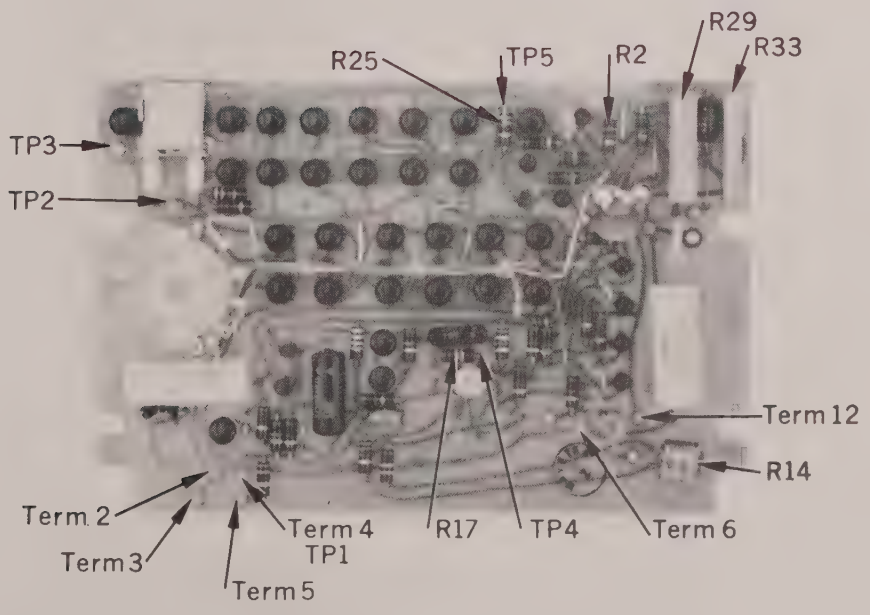


Figure 6-2a

SECTION VII
PARTS LIST

GENERAL

This section contains the list of replaceable electronic parts and assemblies in the equipment; structural items and hardware such as screws and nuts are not included.

PARTS LIST ARRANGEMENT

The parts list starts with the Chassis and Front Panel assembly, Figure 7-1, followed by a list of components found on the Chassis as well as the major modular components.

LIST OF MANUFACTURERS

The MANUFACTURER (MFR) column of the parts list uses brief descriptions; the names are given in full below.

Allen Bradley	Allen Bradley, Milwaukee, Wisconsin
ARCO	Arco Electronics, Great Neck, L. I., New York
Beckman	Beckman Systems Division, Fullerton, California
CDE	Cornell-Dubilier Electronics Division, Newark, New Jersey
Corning	Corning Glass Works, Corning, New York
CRL	Centralab, Division of Globe Union, Milwaukee, Wisconsin
CTS	Chicago Telephone, Pasadena, California
Dickson	Dickson Electronics Corporation, Scottsdale, Arizona
Eldema	Eldema Corporation, Compton, California
Elpac	Elpac Incorporated, Fullerton, California
Erie	Erie Technological Products, Incorporated, Erie, Pennsylvania
Fairchild	Fairchild Semiconductor Corporation, Palo Alto, California
G. E.	General Electric Company, Semiconductor Division, Buffalo, New York

Good-All	Good-All Capacitor Division of TRW, Ogallala, Nebraska
IRC	International Resistance Company, Philadelphia, Pennsylvania
Littelfuse	Littelfuse Incorporated, Des Plaines, Illinois
Mallory	P.R. Mallory and Company, Indianapolis, Indiana
Mektron	California General Corporation Incorporated, Mektron Division, Chula Vista, California
Motorola	Motorola Semiconductor Products, Phoenix, Arizona
Richey	Richey Electronics Incorporated, Nashville, Tennessee
SEC	Southern Electronics Corporation, Burbank, California
Semtech	Semtech Corporation, Newbury Park, California
Sprague	Sprague Electric Company, North Adams, Massachusetts
Stackpole	Stackpole Carbon Company, Saint Mary's, Pennsylvania
TI	Texas Instruments, Incorporated, Dallas, Texas
TRW	TRW Electronics Incorporated, El Segundo, California

MATCHED OR PAIRED PARTS

Prior to ordering or replacing electronic components in the equipment, refer to the notes regarding matched or paired parts on the schematic diagrams in Section VIII.

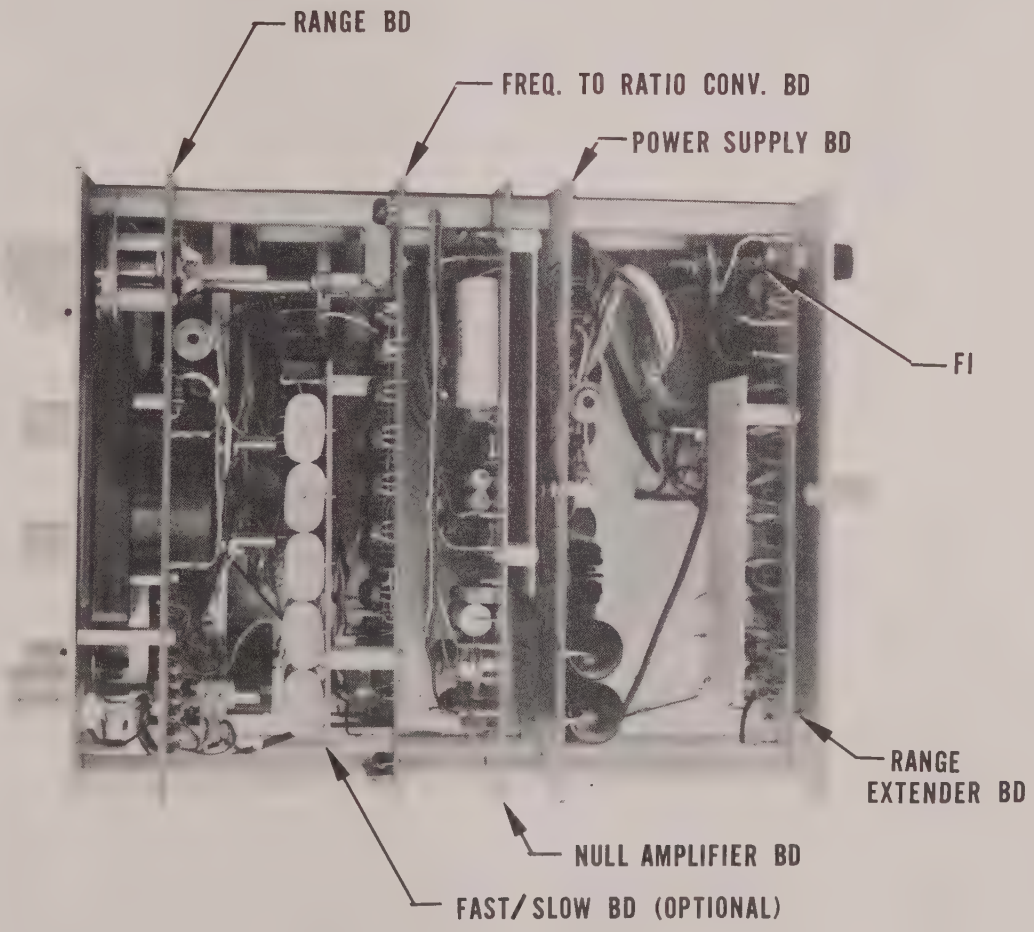
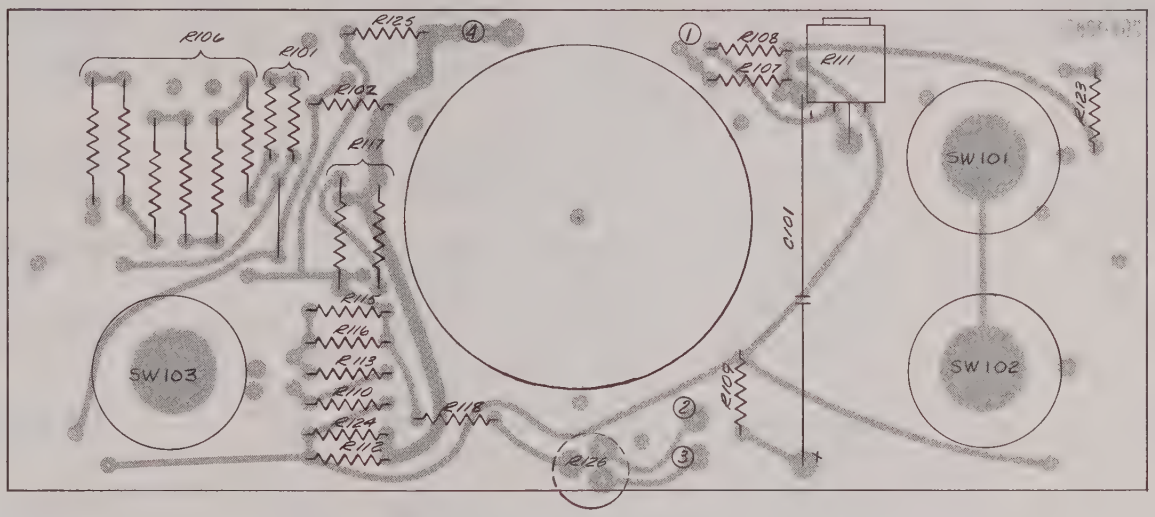


Figure 7-1
Chassis Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
	*--- -008	Range Board Assembly	1	Wavetek
	207-002	Frequency Ratio Converter Board Assembly	1	Wavetek
	203-002	Null Amp Board Assembly (207 only)	1	Wavetek
	201-002	Null Amp Board Assembly (701, 702 only)	1	Wavetek
	207-004	Power Supply Board Assembly	1	Wavetek
	207-005	Range Extender Board Assembly (207, 702 only)	1	Wavetek
F1	312.500	FUSE, 1/2 amp, 3AG	1	Littelfuse
C1	10TM-S10	CAPACITOR, Mylar-Paper, 1000 v, 0.01 μf (207 only)	1	Sprague
R1 thru R11	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.01%, 1000Ω	11	Mektron
R12 thru R22	MK-3	RESISTOR, Wire Wound, 1/4, 0.025%, 200Ω	11	Mektron
R25 thru R35	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 200Ω (Selected)	11	Corning
R23	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.025%, 502Ω	1	Mektron
R24		RESISTOR, Trim, Carbon, 1/2 W (Selected Value)	1	
R36	5311-171-2	POTENTIOMETER, 400Ω	1	Beckman
	201-503	TRANSFORMER	1	Wavetek

* Same As Number Of Machine It Occupies



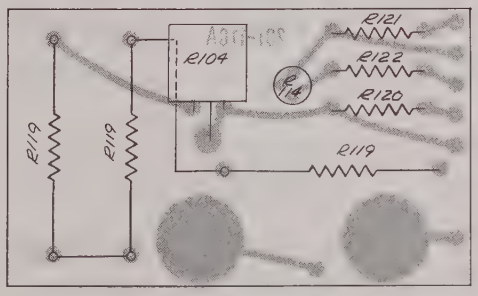


Figure 7-2

Range Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
	201-108D	CIRCUIT BOARD, 3/32 Glass Epoxy	1	Wavetek
	201-110A	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek
R109	RC20GF220K	RESISTOR, Carbon, 1/2 W, 10%, 22Ω	1	Stackpole
R130	RC20GF151K	RESISTOR, Carbon, 1/2 W, 10%, 150Ω	1	Stackpole
R107	RC20GF241J	RESISTOR, Carbon, 1/2 W, 5%, 240Ω	1	Stackpole
R108	RC20GF471K	RESISTOR, Carbon, 1/2 W, 10%, 470Ω	1	Stackpole
R123	RC20GF751J	RESISTOR, Carbon, 1/2 W, 5%, 750Ω	1	Stackpole
R105	RC20GF273K	RESISTOR, Carbon, 1/2 W, 10%, 27,000Ω	1	Stackpole
R118	RC20GF473K	RESISTOR, Carbon, 1/2 W, 10%, 47,000Ω	1	Stackpole
R102	RC20GF105K	RESISTOR, Carbon, 1/2 W, 10%, 10,000,000Ω	1	Stackpole
R115, R116	C5	RESISTOR, Metal Film, 1/4 W, 1%, 10Ω	2	Corning
R129	C5	RESISTOR, Metal Film, 1/4 W, 1%, 12.4Ω	2	Corning
R113	C5	RESISTOR, Metal Film, 1/4 W, 1%, 49.9Ω	1	Corning
R112	C5	RESISTOR, Metal Film, 1/4 W, 1%, 316Ω	1	Corning
R110	C5	RESISTOR, Metal Film, 1/4 W, 1%, 499Ω	1	Corning
R124	C5	RESISTOR, Metal Film, 1/4 W, 1%, 1000Ω	1	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R102	C5	RESISTOR, Metal Film, 1/4 W, 1%, 110,000Ω	1	Corning
R101	C5	RESISTOR, Metal Film, 1/4 W, 1%, 422,000Ω	2	Corning
R106	CEC-TO	RESISTOR, Metal Film, 1/2 W, 1%, 1,500,000Ω	6	IRC
R117	BWH20	RESISTOR, Wire Wound, 1 W, 5%, 0.27Ω	2	IRC
R121	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.01%, 1111.1Ω	1	Mektron
R122	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.025%, 8995Ω	1	Mektron
R120	MK-3	RESISTOR, Wire Wound, 1/4 W, 0.025%, 100,050Ω	1	Mektron
R119	MK-3	RESISTOR, Wire Wound, 3/4 W, 0.025%, 3,300,000Ω	3	Mektron
R125		RESISTOR, Trim, Selected Value	1	
R114	62PR10	POTENTIOMETER, 10Ω	1	Beckman
R104, R111	FR103M	POTENTIOMETER, 10,000Ω	2	Allen-Bradley
R126	FR104M	POTENTIOMETER, 100,000Ω	1	Allen-Bradley
C101	34-750-1760-6T	CAPACITOR, Electrolytic, 6 v, 1750 μf	1	Richey
SW101		SWITCH, Assembly	1	Wavetek
SW102		SWITCH, Assembly	1	Wavetek
SW103		SWITCH, Assembly	1	Wavetek
M1	MM6607-2A	METER	1	Wavetek

Note: Not all of above parts are used on an individual model range board. See range board schematic.

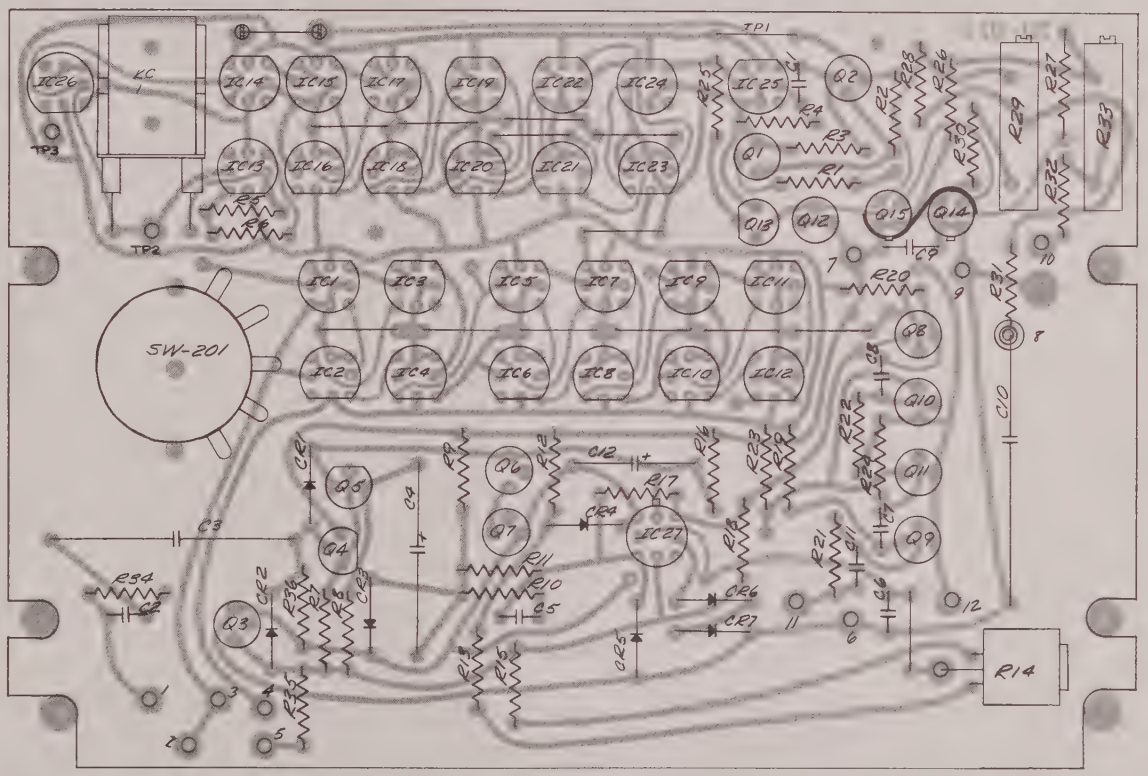


Figure 7-3
Frequency to Ratio Converter Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
	207-102D	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek
R47	RC20GF470K	RESISTOR, Carbon, 1/2 W, 10%, 47 Ω	1	Stackpole
R35	RC20GF680K	RESISTOR, Carbon, 1/2 W, 10%, 68 Ω	1	Stackpole
R21	RC20GF201K	RESISTOR, Carbon, 1/2 W, 10%, 100 Ω	1	Stackpole
R6	RC20GF221K	RESISTOR, Carbon, 1/2 W, 10%, 220 Ω	1	Stackpole
R16	RC20GF391K	RESISTOR, Carbon, 1/2 W, 10%, 390 Ω	1	Stackpole
R5	RC20GF471K	RESISTOR, Carbon, 1/2 W, 10%, 470 Ω	1	Stackpole
R1, R4, R8, R18, R19, R20, R23	RC20GF102K	RESISTOR, Carbon, 1/2 W, 10%, 1000 Ω	7	Stackpole
R22, R24	RC20GF152K	RESISTOR, Carbon, 1/2 W, 10%, 1500 Ω	2	Stackpole
R3, R13	RC20GF332K	RESISTOR, Carbon, 1/2 W, 10%, 3300 Ω	2	Stackpole
R2	RC20GF562K	RESISTOR, Carbon, 1/2 W, 10%, 5600 Ω	1	Stackpole
R7, R10, R11, R12	RC20GF103K	RESISTOR, Carbon, 1/2 W, 10%, 10,000 Ω	4	Stackpole
R15, R34	RC20GF104K	RESISTOR, Carbon, 1/2 W, 10%, 100,000 Ω	2	Stackpole
R17	RC20GF224K	RESISTOR, Carbon, 1/2 W, 10%, 220,000 Ω	1	Stackpole
R9	RC20GF471K	RESISTOR, Carbon, 1/2 W, 10%, 470,000 Ω	1	Stackpole
R36	RC20GF105K	RESISTOR, Carbon, 1/2 W, 10%, 1,000,000 Ω	1	Stackpole

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R27	MK-3	RESISTOR, Wire Wound, 0.05%, 15,000 Ω	1	Mektron
R33	78PR20	POTENTIOMETER, 20 Ω	1	Beckman
R29	75PR200	POTENTIOMETER, 200 Ω	1	Beckman
R14	JAIN104P-1020A	POTENTIOMETER, 10,000 Ω	1	Allen-Bradley
R31	9532F	RESISTOR, 1% 95,300 Ω	1	Corning
C1, C5, C6	DD102	CAPACITOR, Ceramic, 1000 v, 0.001 μf	3	CRL
C9	TGS-30	CAPACITOR, Ceramic, 50 v, 0.03 μf	1	Sprague
C3	663UW	CAPACITOR, Mylar, 400 v, 0.22 μf	1	TRW
C10	X663F	CAPACITOR, Mylar, 200 v, 2 μf	1	Good-All
C10	663UW	CAPACITOR, Mylar, 400 v, 0.22 μf (FAST/SLOW Option Only)	1	TRW
C12	11-215-5-15T	CAPACITOR, Electrolytic, 15 v, 5 μf	1	Richey
C4	11-735-100-15T	CAPACITOR, Electrolytic, 15 v, 100 μf	1	Richey
C2, C7, C8, C11	DD101	CAPACITOR, Ceramic, 1000 v, 100 pf	4	CRL
CR1 thru CR7	FD6666	DIODE	7	Fairchild
Q3, Q6, Q7	2N3638	TRANSISTOR	3	Fairchild
Q1, Q2, Q8, Q9, Q10, Q11	2N3646	TRANSISTOR	6	Fairchild
Q4	2N3819	TRANSISTOR	1	TI

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
Q5, Q13	2N3903	TRANSISTOR	2	Motorola
Q12	2N4342	TRANSISTOR	1	Fairchild
Q14	2N4351	TRANSISTOR	1	Motorola
Q15	2N4352	TRANSISTOR	1	Motorola
IC1 thru IC12, IC14 thru IC26	μL923	Integrated Circuit, Flip Flop	25	Fairchild
IC13	μL914	Integrated Circuit, Crystal Oscillator	1	Fairchild
IC27	μL702C	Integrated Circuit, Amplifier	1	Fairchild
SW201	T-6	SWITCH, 2 Pole, 4 Position	1	Wavetek
Y1	Z-9	CRYSTAL, Quartz, 1 MHz	1	Peterson
R26		RESISTOR, TRIM, Carbon (Selected Value)	1	
R28		RESISTOR, TRIM, Carbon (Selected Value)	1	
R30		RESISTOR, TRIM, Carbon (Selected Value)	1	
R32		RESISTOR, TRIM, Carbon (Selected Value)	1	

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C13 thru C17	X663F	CAPACITOR, Mylar, 200 v, 4 μf	5	TRW
	701-101	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek

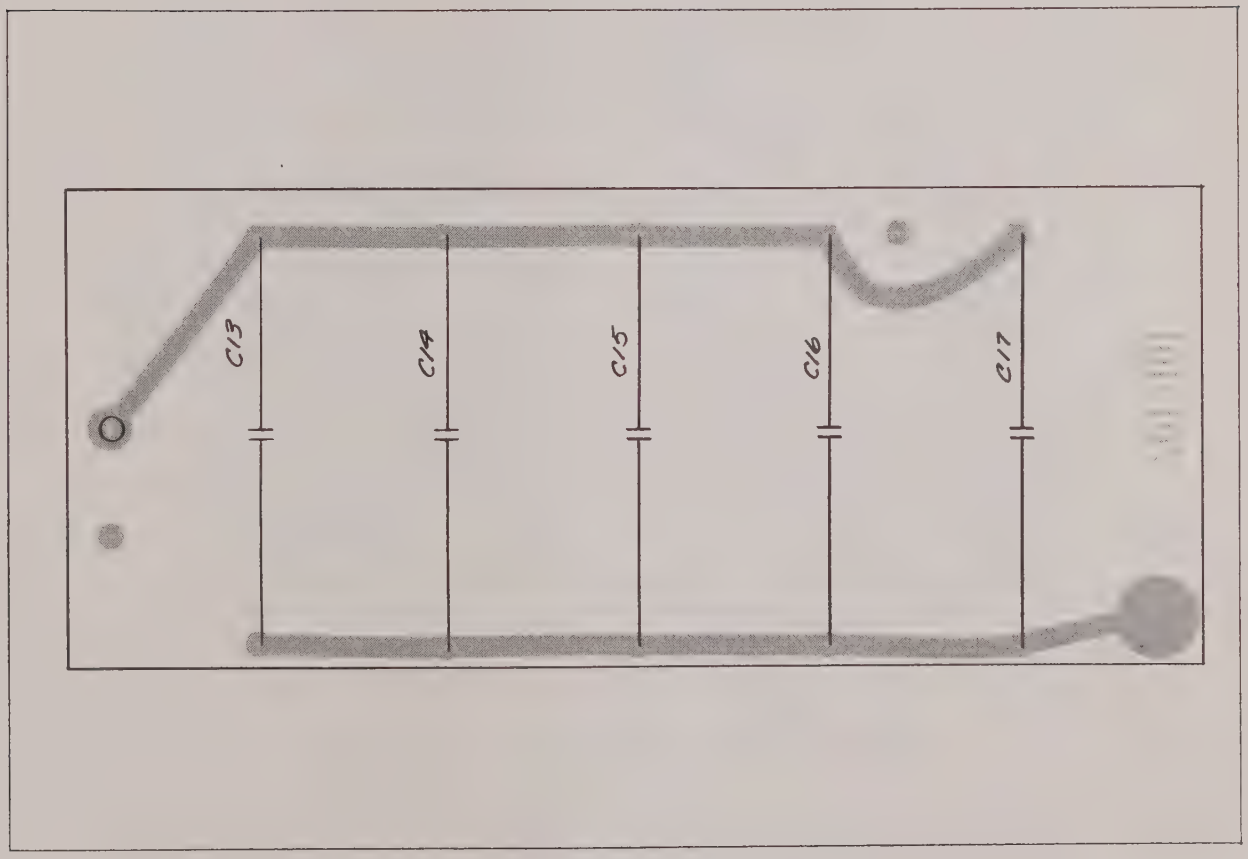


Figure 7-4
Filter Sub-board Assembly
(Optional)

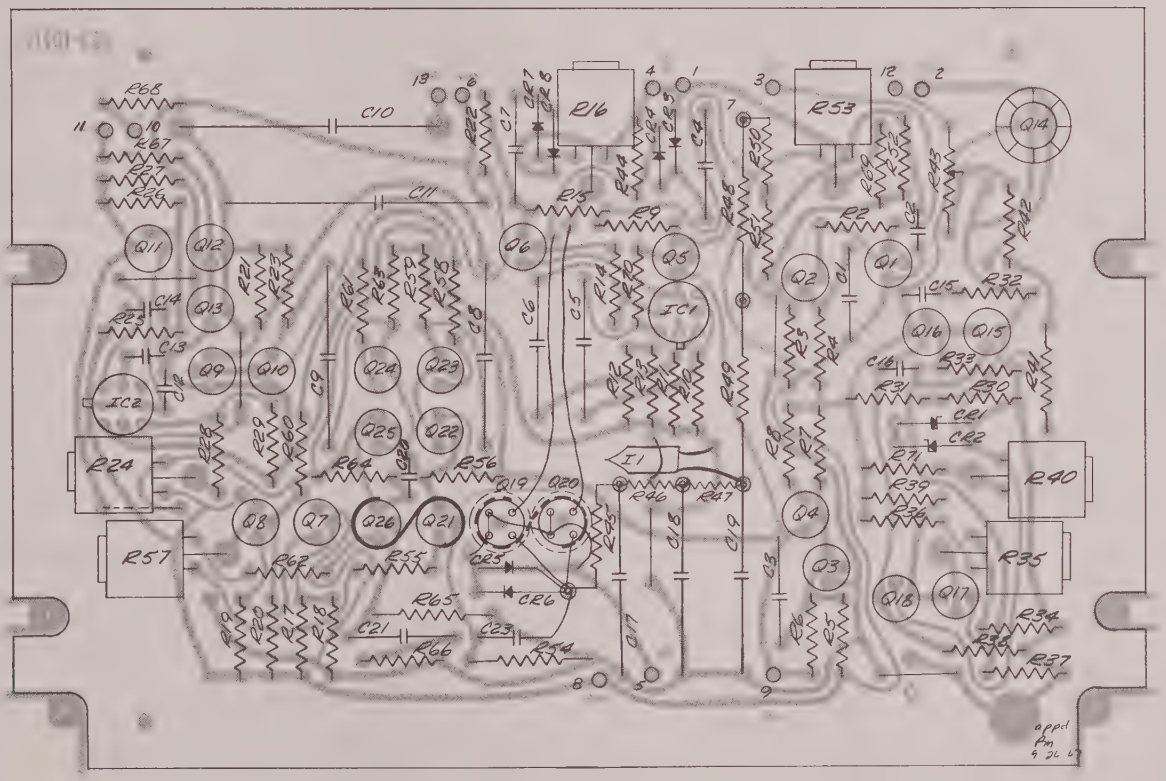


Figure 7-5
Null Amplifier Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R52	RC20GF100K	RESISTOR, Carbon, 1/2 W, 10%, 10Ω	1	Stackpole
R58, R61	RC20GF470K	RESISTOR, Carbon, 1/2 W, 10%, 47Ω	2	Stackpole
R12	RC20GF331K	RESISTOR, Carbon, 1/2 W, 10%, 330Ω	1	Stackpole
R8	RC20GF391K	RESISTOR, Carbon, 1/2 W, 10%, 390Ω	1	Stackpole
R32	RC20GF821K	RESISTOR, Carbon, 1/2 W, 10%, 820Ω	1	Stackpole
R17, R18, R20, R60	RC20GF222K	RESISTOR, Carbon, 1/2 W, 10%, 2200Ω	4	Stackpole
R2	RC20GF392K	RESISTOR, Carbon, 1/2 W, 10%, 3900Ω	1	Stackpole
R7, R9, R14, R15, R22, R59, R63, R67, R68, R70	RC20GF472K	RESISTOR, Carbon, 1/2 W, 10%, 4700Ω	10	Stackpole
R39	RC20GF682K	RESISTOR, Carbon, 1/2 W, 10%, 6800Ω	1	Stackpole
R27, R29	RC20GF103K	RESISTOR, Carbon, 1/2 W, 10%, 10,000Ω	2	Stackpole
R33	RC20GF153K	RESISTOR, Carbon, 1/2 W, 10%, 15,000Ω	1	Stackpole
R21, R23	RC20GF223K	RESISTOR, Carbon, 1/2 W, 10%, 22,000Ω	2	Stackpole
R37, R38	RC20GF273K	RESISTOR, Carbon, 1/2 W, 10%, 27,000Ω	2	Stackpole
R19	RC20GF563K	RESISTOR, Carbon, 1/2 W, 10%, 56,000Ω	1	Stackpole
R31, R44	RC20GF104K	RESISTOR, Carbon, 1/2 W, 10%, 100,000Ω	2	Stackpole

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R69	RC20GF274K	RESISTOR, Carbon, 1/2 W, 10%, 270,000Ω	1	Stackpole
R50, R51	RC20GF564J	RESISTOR, Carbon, 1/2 W, 5%, 560,000Ω	2	Stackpole
R30	RC20GF105K	RESISTOR, Carbon, 1/2 W, 10%, 1,000,000Ω	1	Stackpole
R28	RC20GF224K	RESISTOR, Carbon, 1/2 W, 10%, 2,200,000Ω	1	Stackpole
R46, R47	RC20GF274K	RESISTOR, Carbon, 1/4 W, 10%, 270,000Ω	2	Stackpole
R48, R49	RC20GF154K	RESISTOR, Carbon, 2 W, 10%, 150,000Ω	2	Stackpole
R71	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 453Ω (499Ω Model 205, 206 only)	1	Corning
R26	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 2,490Ω	1	Corning
R36	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 3,160Ω	1	Corning
R3, R55, R62	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 4,640Ω	3	Corning
R6	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 5,760Ω	1	Corning
R5	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 6,980Ω	1	Corning
R25	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 10,000Ω	1	Corning
R34	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 12,100Ω	1	Corning
R4	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 15,000Ω	1	Corning
R10, R11	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 21,500Ω	2	Corning

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R45, R56, R64, R66	RN60D	RESISTOR, Metal Film, 1/4 W, 1%, 464,000Ω	4	Corning
R54, R65	RN60D	RESISTOR, Metal Film, 1/2 W, 1%, 1,500,000Ω	2	Corning
R13		RESISTOR, Trim, Carbon	1	
R41*		RESISTOR, Trim, Metal Film, 1/4 W, 1%	1	
R42*		RESISTOR, Trim, Wire Wound, 0.1%	1	
R43*	78PR20	POTENTIOMETER, 20Ω	1	Beckman
R40*	FR101M	POTENTIOMETER, 100Ω	1	Allen-Bradley
R35, R57	FR252M	POTENTIOMETER, 2,500Ω	2	Allen-Bradley
R16, R24, R53	FR104M	POTENTIOMETER, 100,000Ω	3	Allen-Bradley
C20	DD101	CAPACITOR, Ceramic, 1000 v, 100 pf	1	CRL
C15, C16	CK103	CAPACITOR, Ceramic, 50 v, 0.01 μf	2	CRL
C1, C3, C21	WMFISI	CAPACITOR, Mylar, 100 v, 0.01 μf	3	CDE
C2, C12, C13, C14	UK10-104	CAPACITOR, Ceramic, 10 v, 0.1 μf	4	CRL
C8, C9	WMFIS47	CAPACITOR, Mylar, 100 v, 0.047 μf	2	CDE
C5, C6	X633F	CAPACITOR, Mylar, Matched pair, 200 v, 0.33 μf	1	TRW
C17, C18, C19	POLO4-L1	CAPACITOR, Polystyrene, 100 v, 0.1 μf	3	SEC

* Omit For Models 205 and 206.

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
C11	MD1A105	CAPACITOR, Mylar, 100 v, 1 μf	1	Elpac
C23	X633F	CAPACITOR, Mylar, 0.01 μf	1	TRW
C10	X633F	CAPACITOR, Mylar, 200 v, 4 μf	1	TRW
C4, C7	150D	CAPACITOR, Tantalum, 35 v, 5.6 μf	2	Sprague
Q14	2N3299	TRANSISTOR	1	Fairchild
Q2, Q9, Q13, Q17, Q18	2N3565	TRANSISTOR	5	Fairchild
Q3, Q4, Q7, Q8, Q11, Q12, Q15, Q16, Q23, Q24	2N3638	TRANSISTOR	10	Fairchild
Q1, Q5, Q6	2N3642	TRANSISTOR	3	Fairchild
Q10, Q22, Q25	2N4248	TRANSISTOR	3	Fairchild
Q19	2N4351	TRANSISTOR	1	Motorola
Q20	2N4352	TRANSISTOR	1	Motorola
Q21, Q26	2N4250	TRANSISTOR, Matched Pair	1	Fairchild
CR3, CR4, CR5, CR6, CR7, CR8	FD6666	DIODE	6	Fairchild
CR1, CR2	DT50920	DIODE, Zener, Matched Pair	1	Dickson
IC1	μL914	INTEGRATED CIRCUIT	1	Fairchild
IC2	μA702C	INTEGRATED CIRCUIT, Amplifier	1	Fairchild
I1	NE2P	INDICATOR LAMP, Neon	1	Eldema
	203-102B	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek

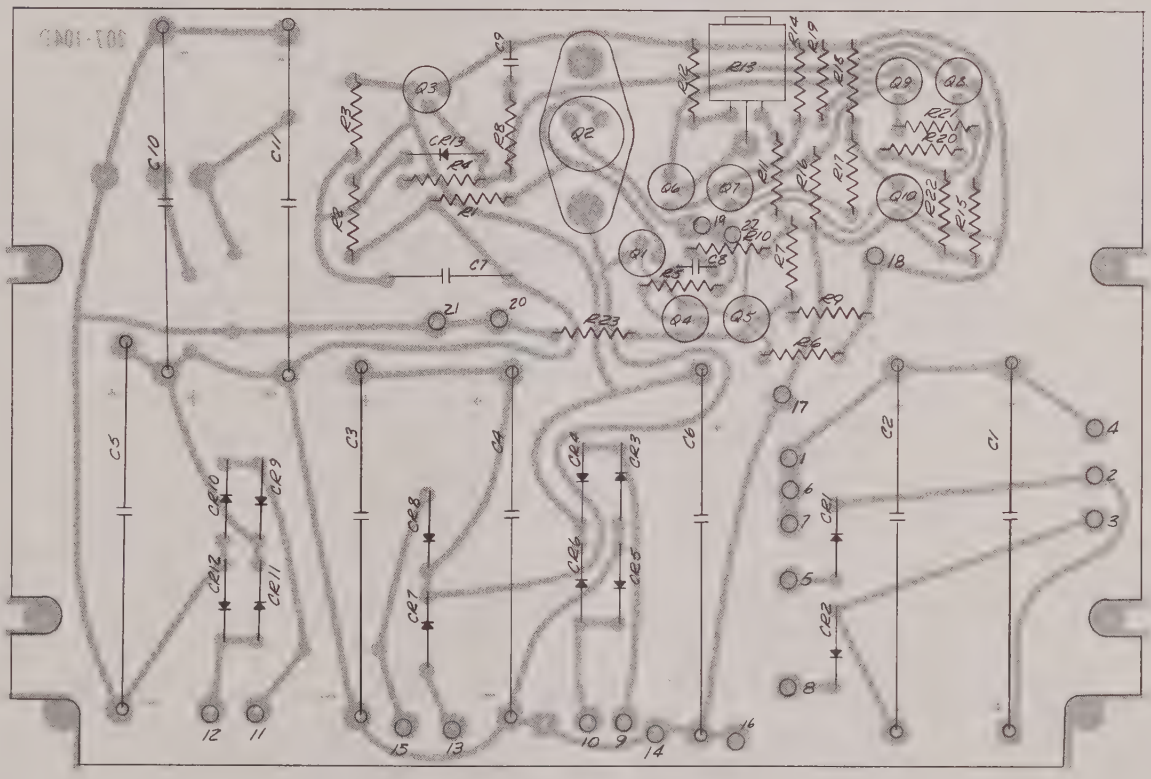


Figure 7-6
Power Supply Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
	207-104D	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek
R20, R21	RC20GF470K	RESISTOR, Carbon, 1/2 W, 10%, 47Ω	2	Stackpole
R19	RC20GF101K	RESISTOR, Carbon, 1/2 W, 10%, 100Ω	1	Stackpole
R8	RC20GF151K	RESISTOR, Carbon, 1/2 W, 10%, 150Ω	1	Stackpole
R23	RC20GF102K	RESISTOR, Carbon, 1/2 W, 10%, 1000Ω	1	Stackpole
R22	RC20GF222K	RESISTOR, Carbon, 1/2 W, 10%, 2200Ω	1	Stackpole
R5, R7	RC20GF272K	RESISTOR, Carbon, 1/2 W, 10%, 2700Ω	2	Stackpole
R4	RC20GF332K	RESISTOR, Carbon, 1/2 W, 10%, 3300Ω	1	Stackpole
R6	RC20GF392K	RESISTOR, Carbon, 1/2 W, 10%, 3900Ω	1	Stackpole
R1, R17	RC20GF472K	RESISTOR, Carbon, 1/2 W, 10%, 4700Ω	2	Stackpole
R11	RC20GF562K	RESISTOR, Carbon, 1/2 W, 10%, 5600Ω	1	Stackpole
R18	RC20GF622K	RESISTOR, Carbon, 1/2 W, 10%, 6200Ω	1	Stackpole
R2, R3	RC20GF103K	RESISTOR, Carbon, 1/2 W, 10%, 10,000Ω	2	Stackpole
R9, R12	RC20GF163K	RESISTOR, Carbon, 1/2 W, 10%, 16,000Ω	2	Stackpole
R15, R16	RC20GF473K	RESISTOR, Carbon, 1/2 W, 10%, 47,000Ω	2	Stackpole
R14	RC20GF913K	RESISTOR, Carbon, 1/2 W, 10%, 91,000Ω	1	Stackpole

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
R10	RC20GF152K	RESISTOR, Carbon, 1/2 W, 10%, 1500 Ω	1	Stackpole
R13	FR-252M	POTENTIOMETER, 2500 Ω	1	Allen-Bradley
C9	CK-103	CAPACITOR, Ceramic, 50 v, 0.01 μf	1	CRL
C7	X663F	CAPACITOR, Mylar, 200 v, 0.33 μf	1	Good-All
C6	34-750-500-50T	CAPACITOR, Electrolytic, 50 v, 500 μf	1	Richey
C1, C2	34-750-1000-35T	CAPACITOR, Electrolytic, 35 v, 1000 μf	2	Richey
C3, C4, C5, C10, C11	34-750-BP-2000	CAPACITOR, Electrolytic, 15 v, 2000 μf	5	Richey
C8	DD102	CAPACITOR, Ceramic, 1000 v, 0.001 μf	1	CRL
CR3, CR4, CR5, CR6, CR13	FD6666	DIODE	5	Fairchild
CR1, CR2, CR7, CR8, CR9, CR10, CR11, CR12	SCE-1	DIODE	8	Semtech
Q1	2N3646	TRANSISTOR	1	Fairchild
Q8, Q9	2N3565	TRANSISTOR	2	Fairchild
Q10	2N3638	TRANSISTOR	1	Fairchild
Q6, Q7	2N4248	TRANSISTOR	2	Fairchild
Q2	40250	TRANSISTOR	1	RCA
Q3	2N3502	TRANSISTOR	1	Fairchild
Q4, Q5	2N3642	TRANSISTOR	2	Fairchild

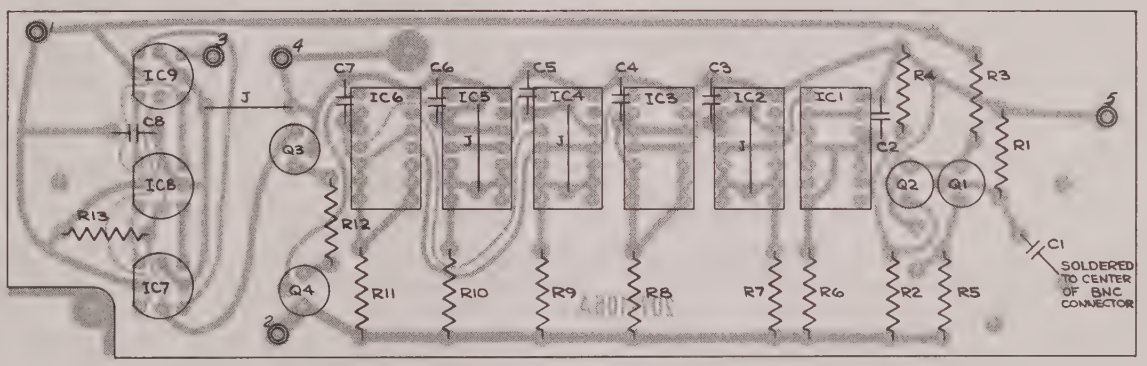


Figure 7-7

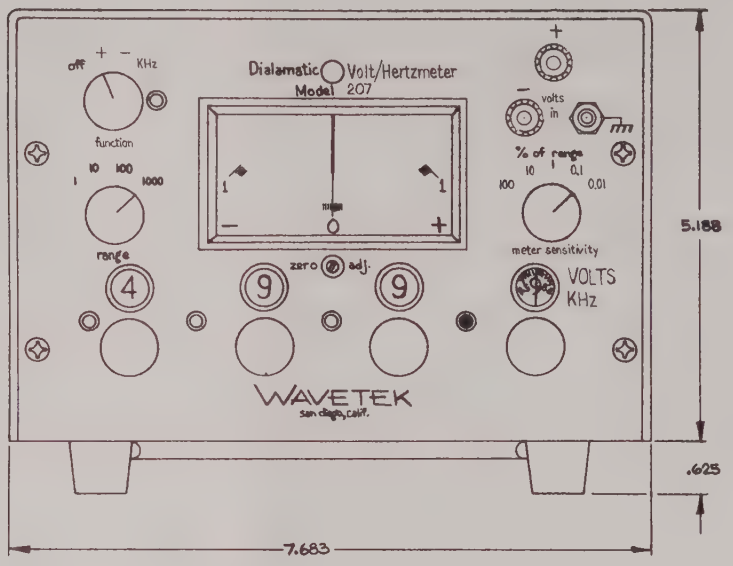
Range Extender Board Assembly

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
	207-105A	CIRCUIT BOARD, 1/16 Glass Epoxy	1	Wavetek
R5	RC20GF100K	RESISTOR, Carbon, 1/2 W, 10%, 10Ω	1	Stackpole
R12	RC20GF180K	RESISTOR, Carbon, 1/2 W, 10%, 18Ω	1	Stackpole
R6, R7	RC20GF470K	RESISTOR, Carbon, 1/2 W, 10%, 47Ω	2	Stackpole
R1	RC20GF510J	RESISTOR, Carbon, 1/2 W, 5%, 51Ω	1	Stackpole
R8, R9, R10, R11	RC20GF820K	RESISTOR, Carbon, 1/2 W, 10%, 82Ω	4	Stackpole
R4	RC20GF910J	RESISTOR, Carbon, 1/2 W, 5%, 91Ω	1	Stackpole
R3	RC20GF201J	RESISTOR, Carbon, 1/2 W, 5%, 200Ω	1	Stackpole
R13	RC20GF102K	RESISTOR, Carbon, 1/2 W, 10%, 1000Ω	1	Stackpole
R2		RESISTOR, TRIM, Carbon (Selected Value)	1	
C1 thru C8	UK10-104	CAPACITOR, Ceramic, 10 v, 0.1 μf	8	CRL
Q4	2N3640	TRANSISTOR	1	Fairchild
Q3	2N3646	TRANSISTOR	1	Fairchild
Q1, Q2	2N4313	TRANSISTOR	2	Fairchild
IC3 thru IC6	MC1013P	Integrated Circuit, 70 MHz Flip Flop	4	Motorola
IC2	MC1027P	Integrated Circuit, 120 MHz Flip Flop	1	Motorola
IC1	MC1023P	Integrated Circuit, Clock Driver	1	Motorola

Range Extender Board Assembly, Parts List

CIRCUIT REFERENCE	PART NO.	DESCRIPTION	QTY	MFR
IC7 thru IC9	μL923	Integrated Circuit, Flip Flop	3	Fairchild

SECTION VIII
SCHEMATIC DIAGRAMS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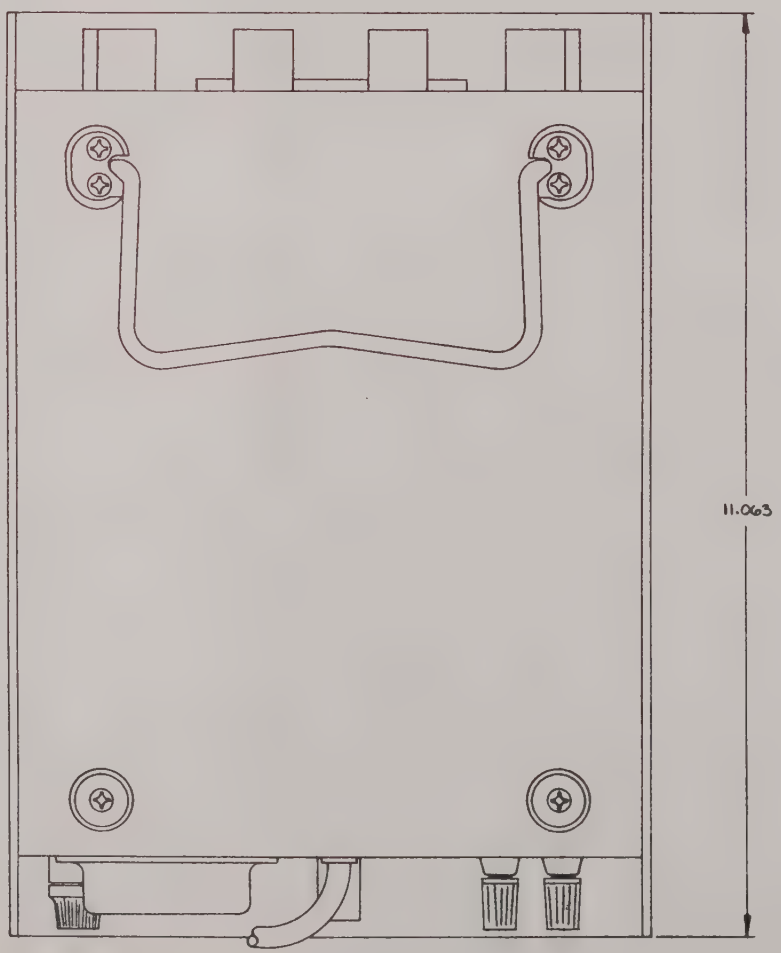
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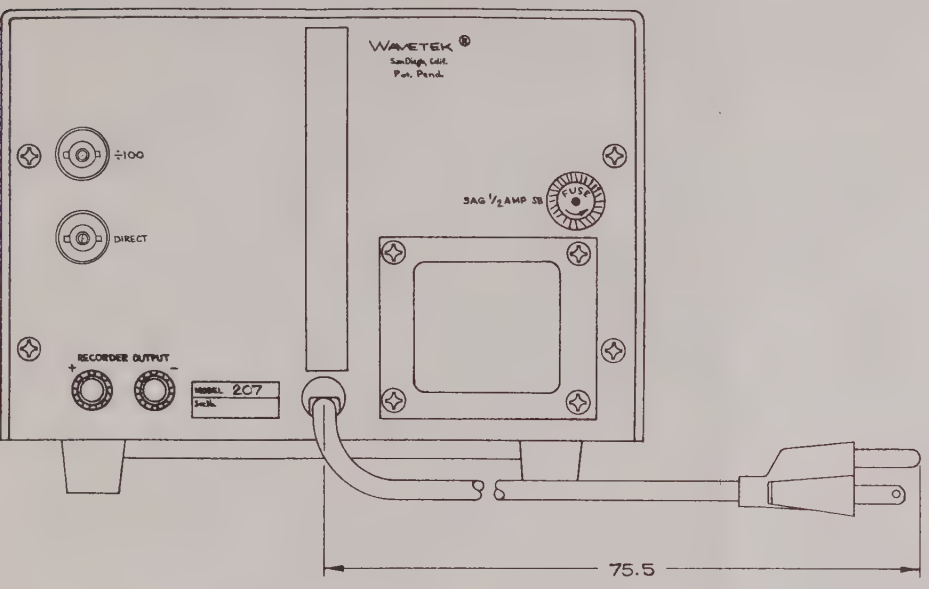

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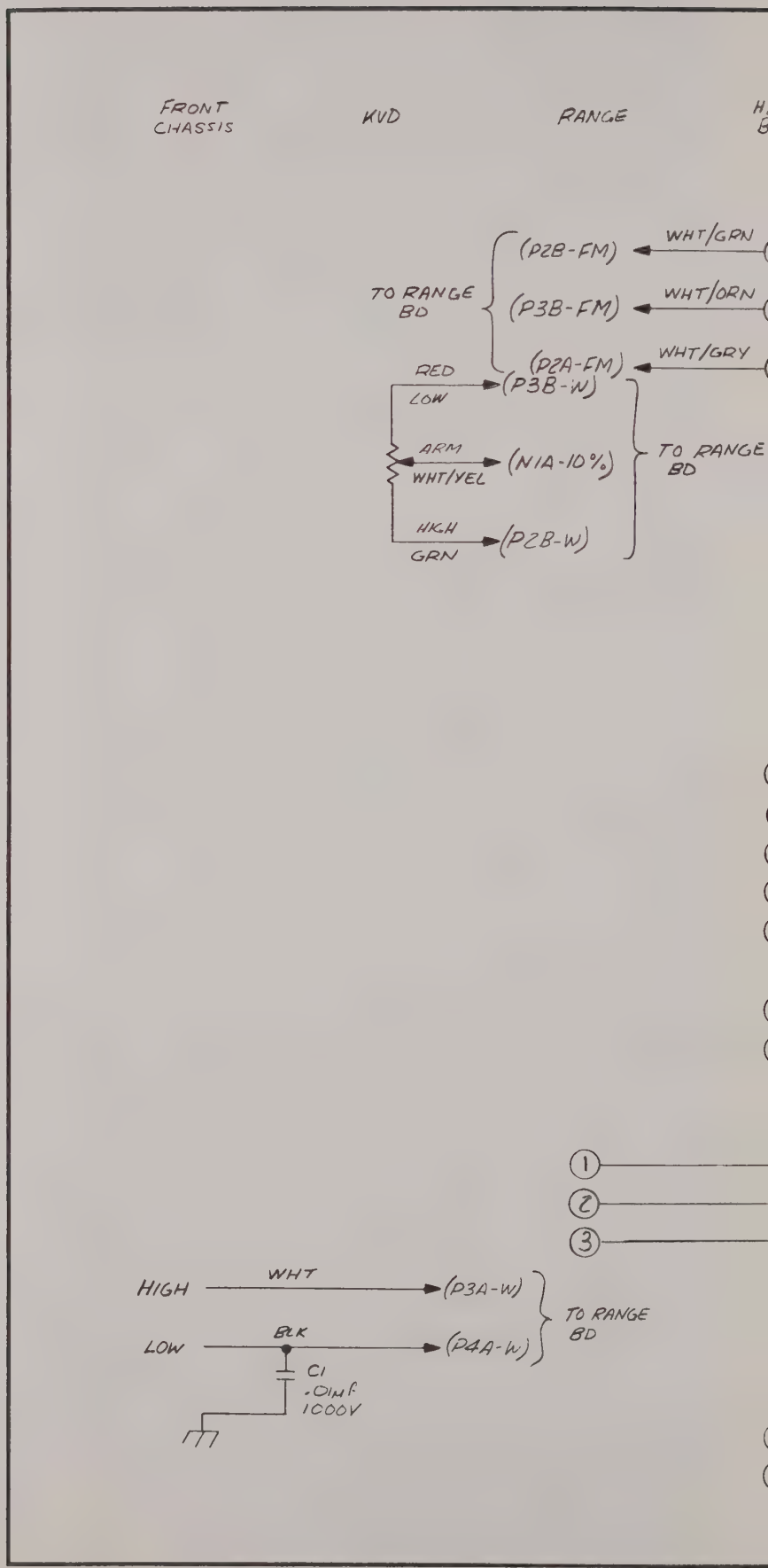
scale FULL	by L. ADAMSON	date 9/14/67	app.		
material N/A	title OUTLINE DRAWING				
	model no. 207	dwg no. 207-601	rev		
finish N/A	this document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except calibration, operation and maintenance without written authorization.				


FRONT CHASSIS
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WHT/GRN
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WHT/GRY
RED
LOW
(P3B-W)
ARM
WHT/YEL
(N1A-10%)
TO RANGE BD
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GRN
(P2B-W)
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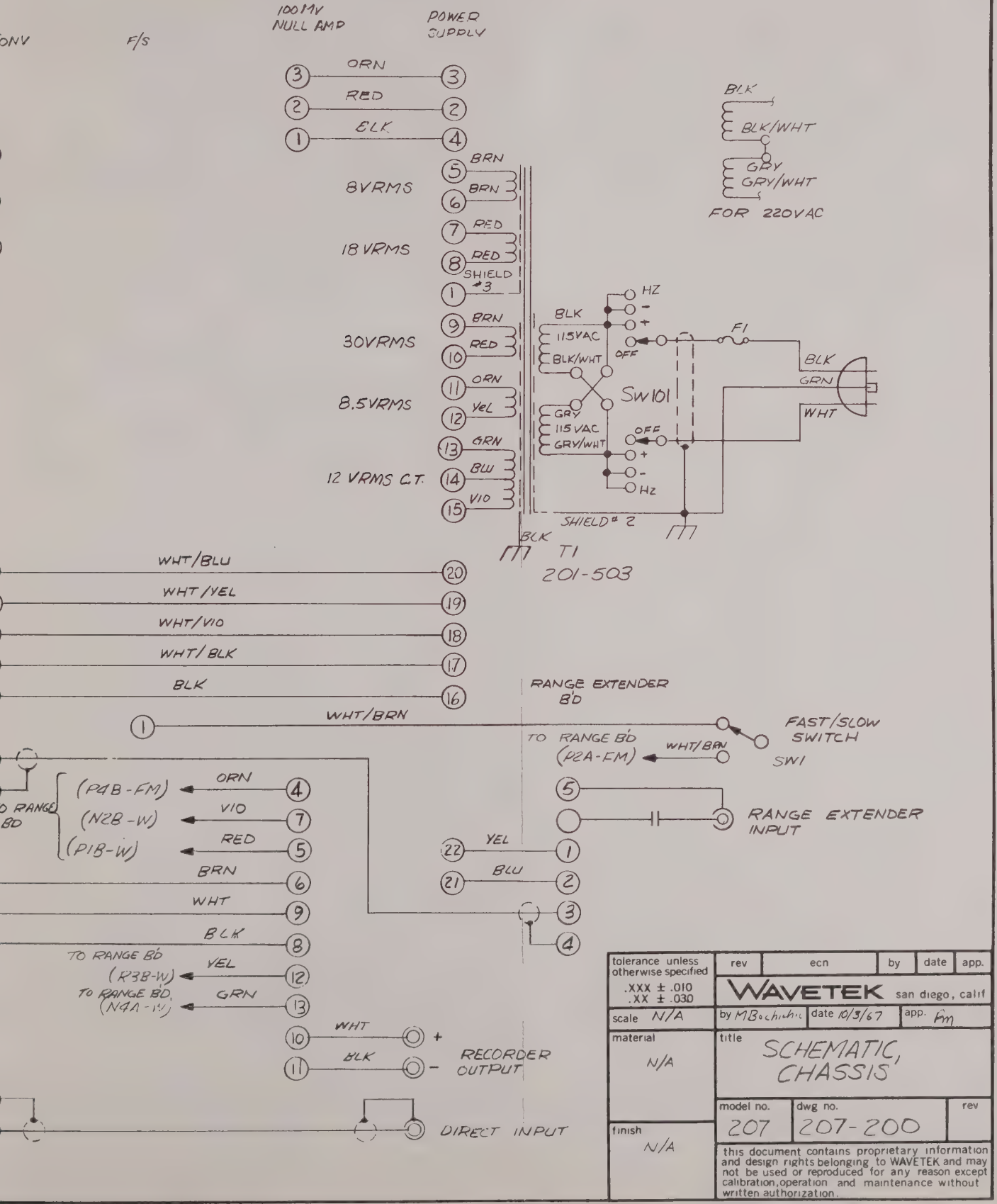

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scale N/A	by MBochinski	date 10/3/67	app. fm		
material N/A	title SCHEMATIC, CHASSIS				
finish N/A	model no. 207	dwg no. 207-200	rev		

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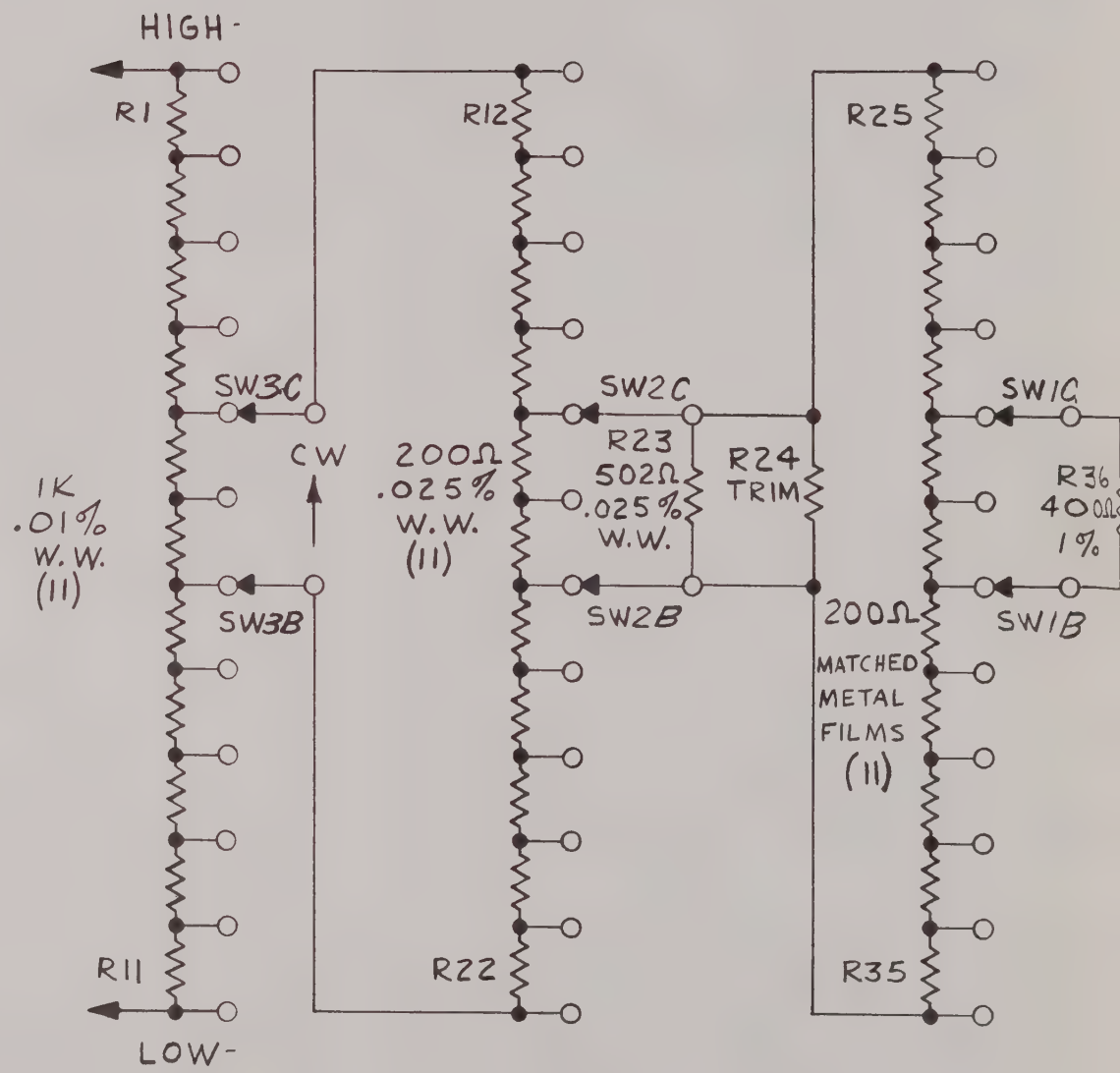
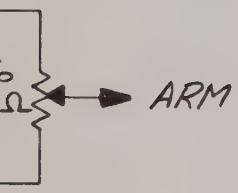

HIGH-
R1
R12
R25
SW3C
SW2C
SW1C
CW
200Ω
.025%
W.W.
(11)
R23
502Ω
.025%
W.W.
R24
TRIM
R36
40Ω
1%
1K
.01%
W.W.
(11)
SW3B
SW2B
SW1B
200Ω
MATCHED
METAL
FILMS
(11)
R11
R22
R35
LOW-



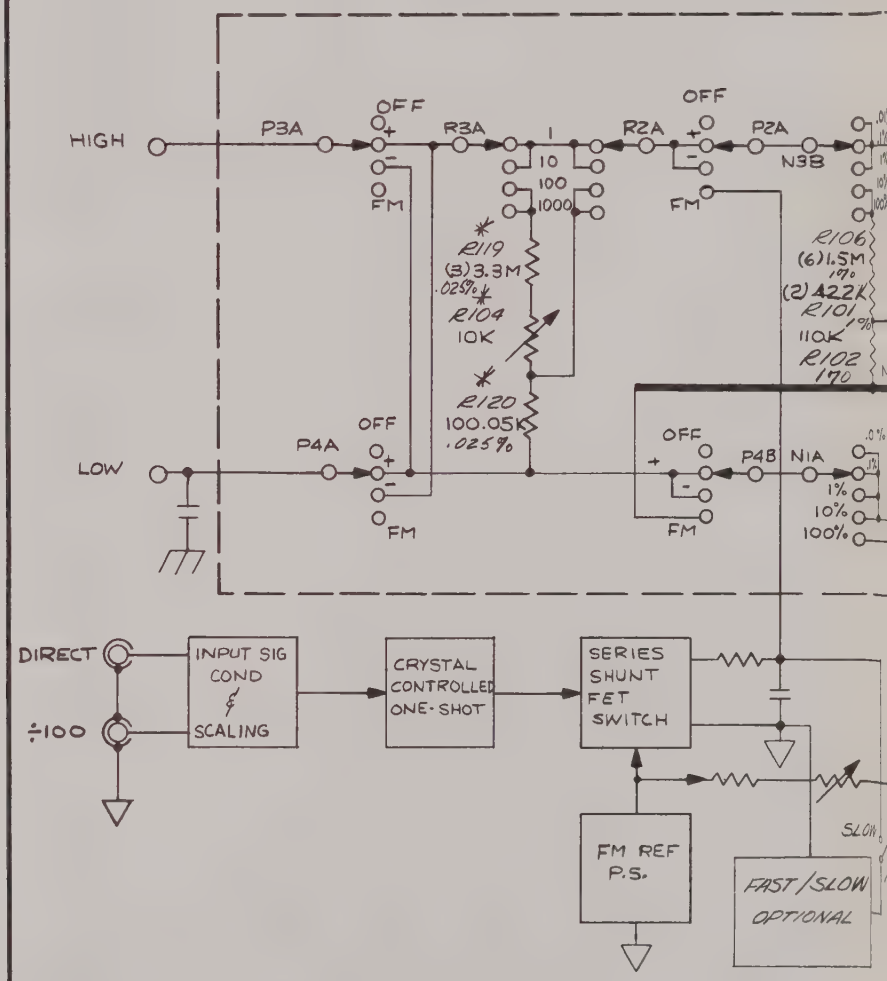
B	—	MBo	10/6/67	
A		SL.B.	10-31-66	
CHG	ECN NO.	BY	DATE	APP.

WAVETEK 8159 ENGINEER RD SAN DIEGO, CALIF

DWN: DATE: 9-15-66 APPD

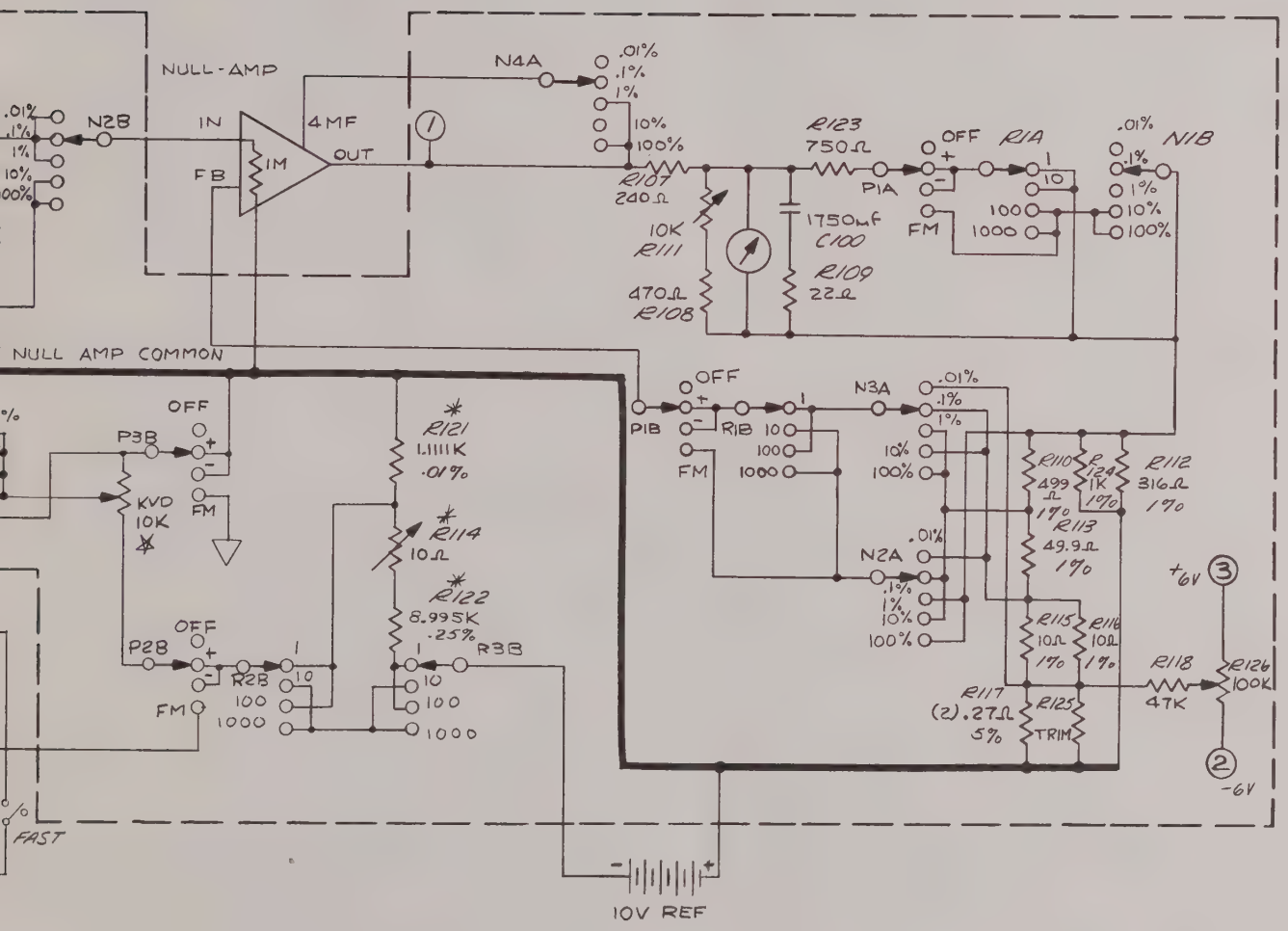
KELVIN-VARLEY DIVIDER

MODEL 201-204, 207, 701+702 200-200B



NOTES:

1. ⏚ INDICATES CHASSIS GROUND
2. ▽ FREQUENCY METER COMMON
3. SWITCH NOMENCLATURE
   a. FIRST LETTER INDICATES SWITCH FUNCTION (N = NULL SENSITIVI
      R = RANGE, SW102, P = POLARITY, SW101)
   b. NUMBER INDICATES WAFER LOCATION (1 IS WAFER CLOSE
      TO FRONT PANEL)
   c. SECOND LETTER INDICATES SWITCH POLE (A INDICATES LEF
      AS VIEWED FROM FRONT)
4. ✱ LOCATED ON BOARD 201-010A ONLY
5. ✱ SCHEMATIC 200-200B



tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale N/A	by M E B	date 8-28-67	app.		
material N/A	title SCHEMATIC RANGE B'D				
finish N/A	model no. 207	dwg no. 207-208	rev A		

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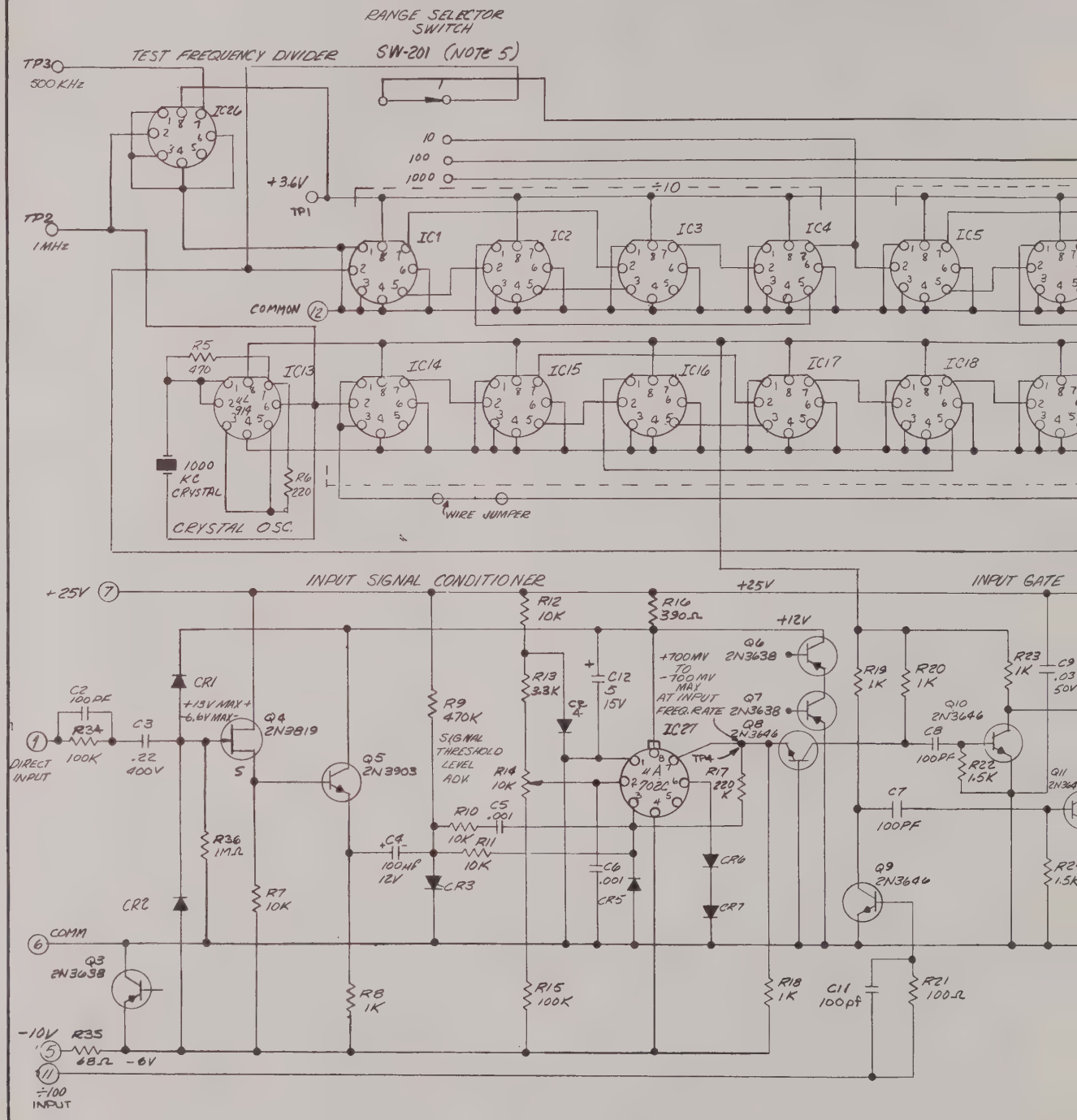
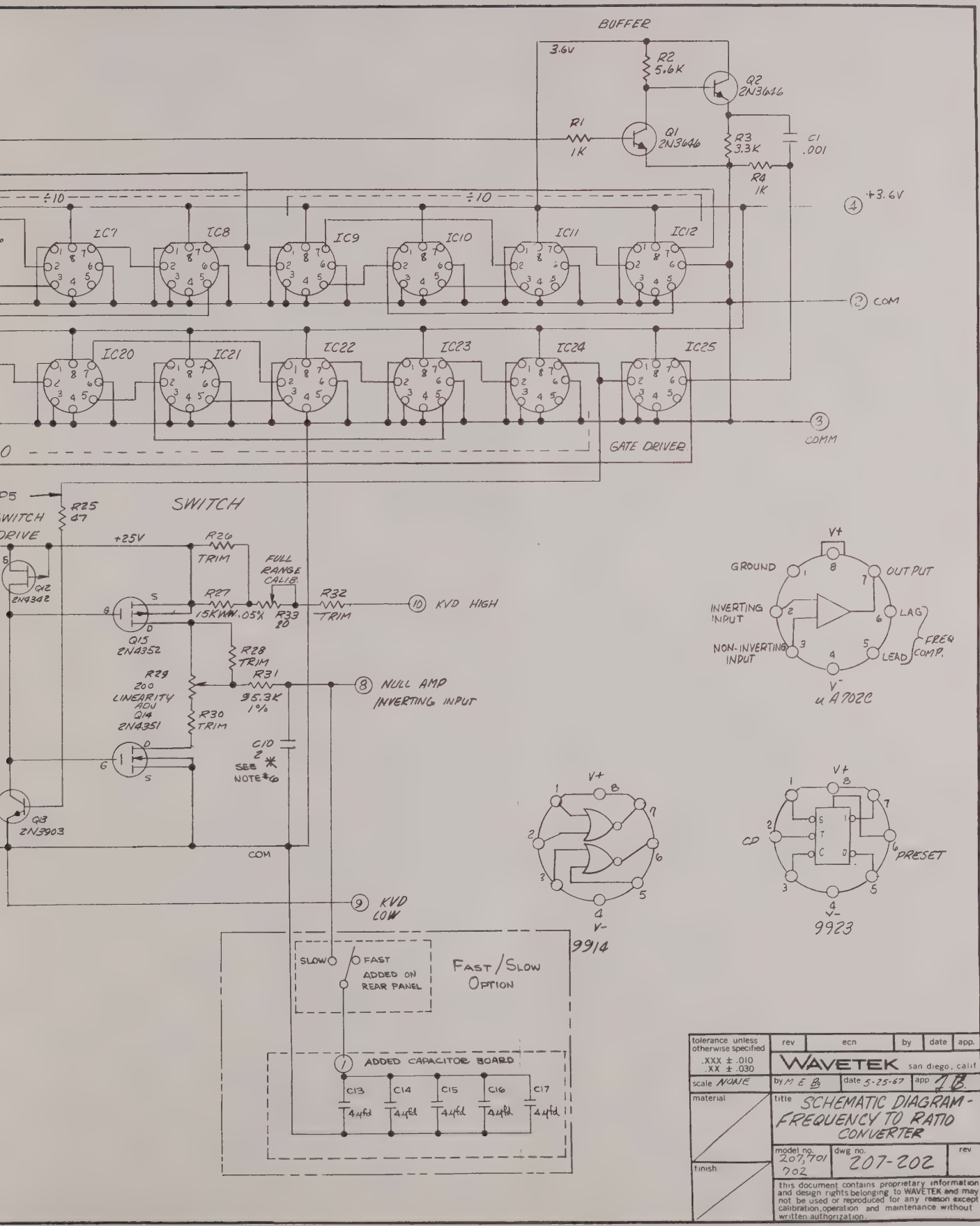
ITY, SW 103
EST
T POLE



LAST COMP DESIGNATORS
R36
C17
Q15
CR7
IC 27

NOTES UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, 10%
2. ALL CAPACITORS ARE IN MICROFARADS (μF)
3. ALL DIODES ARE FD6666
4. ALL IC's ARE 9923
5. GANGED WITH SW102 ON RANGE BD
6. FOR FAST/SLOW OPTION, REPLACE 2 μfd (C10) WITH .22 μfd.



tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
		WAVETEK san diego, calif			
scale NONE	by M E B	date 5-25-67	app J B		
material	title SCHEMATIC DIAGRAM - FREQUENCY TO RATIO CONVERTER				
finish	model no. 207,701 702	dwg no. 207-202	rev		

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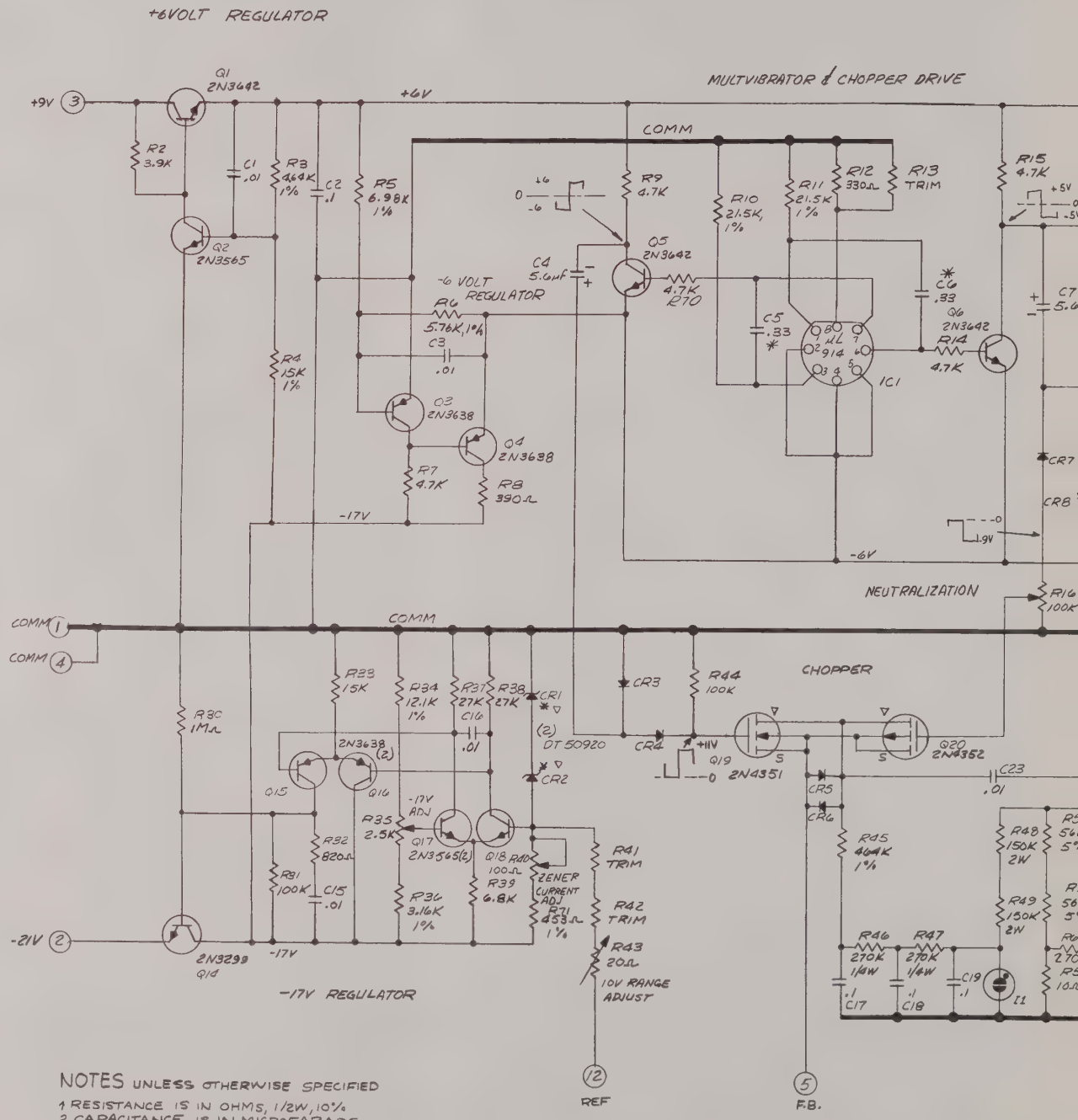
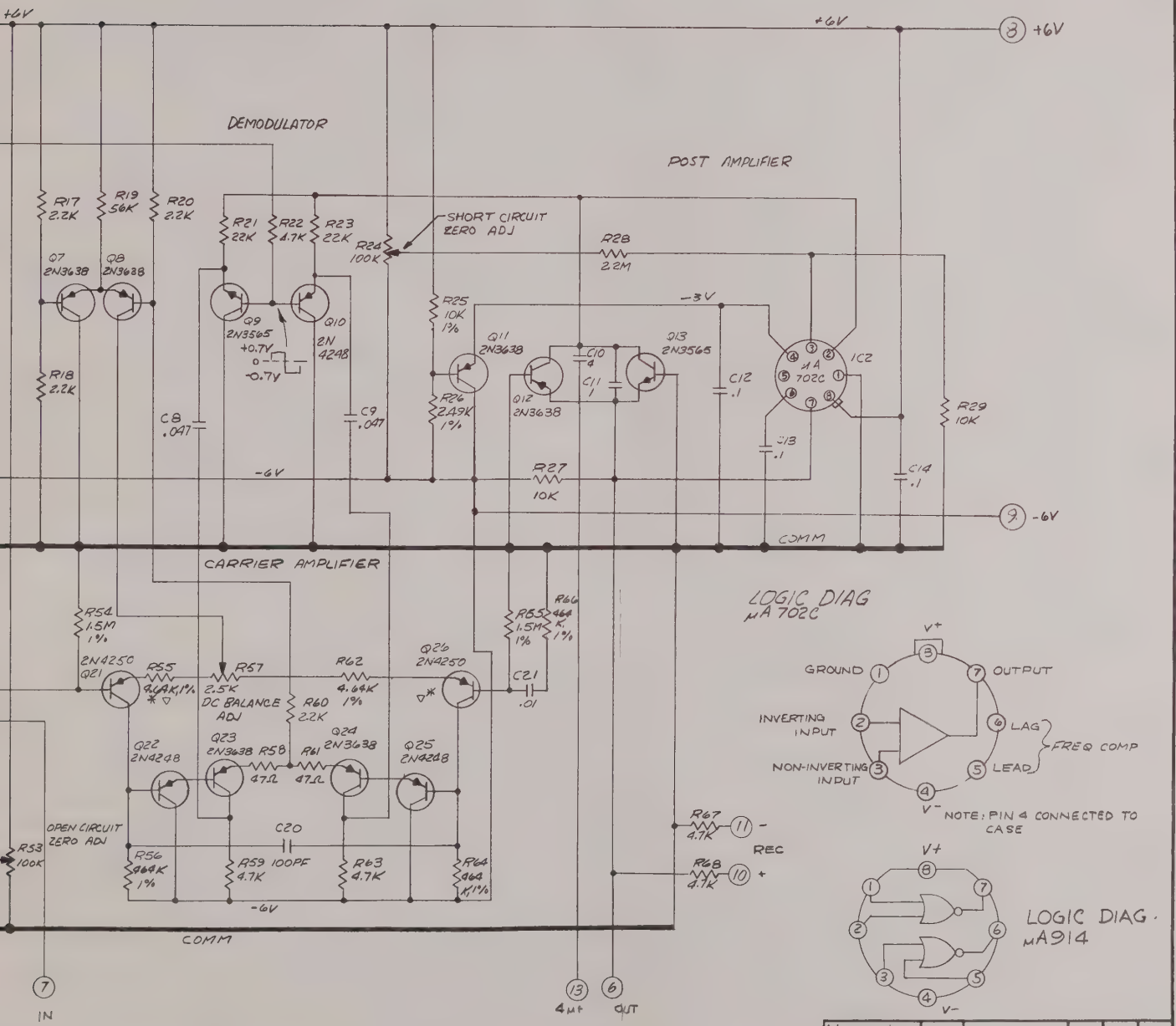


NOTES UNLESS OTHERWISE SPECIFIED

1 RESISTANCE IS IN OHMS, 1/2W, 10%
2 CAPACITANCE IS IN MICROFARADS
3 DIODES ARE FD6660
4* INDICATES MATCHED PAIR
5▽ INDICATES THERMALLY LINKED



COMPONENT DESIGNATOR

R71
C23
CR8
Q26
IC2

A	#181 #194	ENH	12-1-67	
REV	ECN	BY	DATE	APP

tolerance unless otherwise specified	rev	ecn	by	date	app.
.XXX ± .010 .XX ± .030	WAVETEK san diego, calif				
scale N/A	by M. E. Bo	date 7-10-67	app.		
material N/A	title SCHEMATIC— NULL AMPLIFIER B'D				
finish N/A	model no. 203, 204, 207	dwg no. 203-202	rev A		

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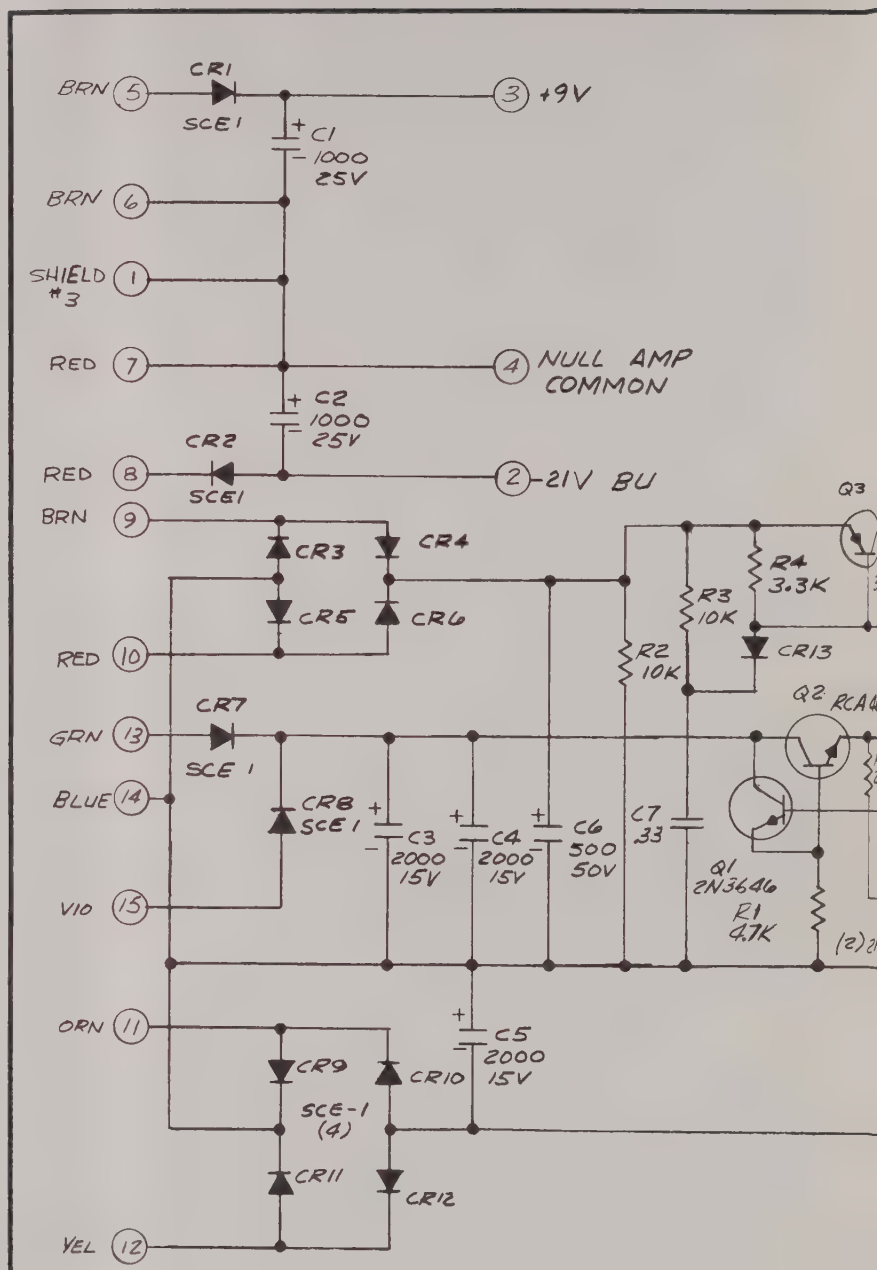
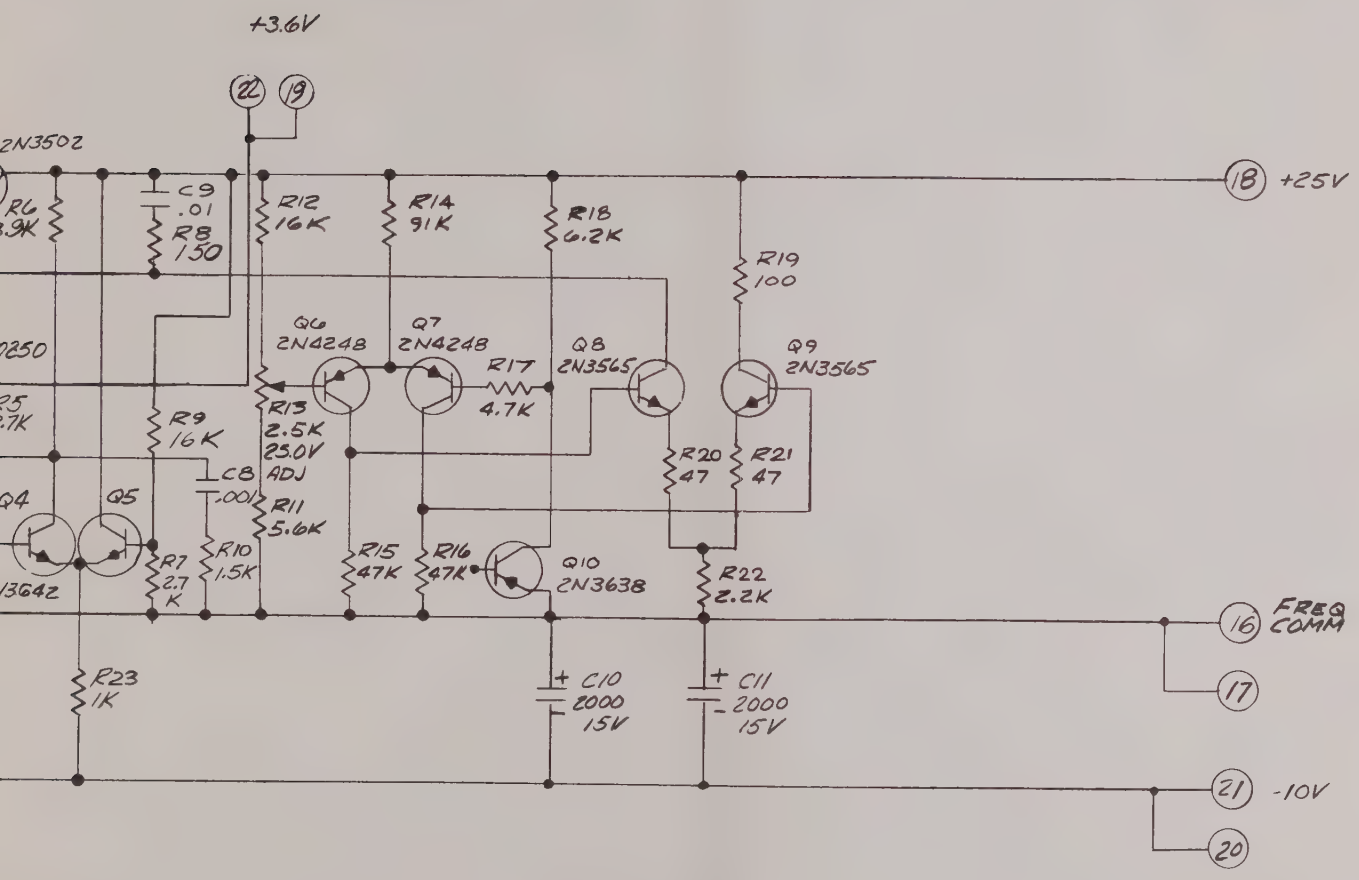


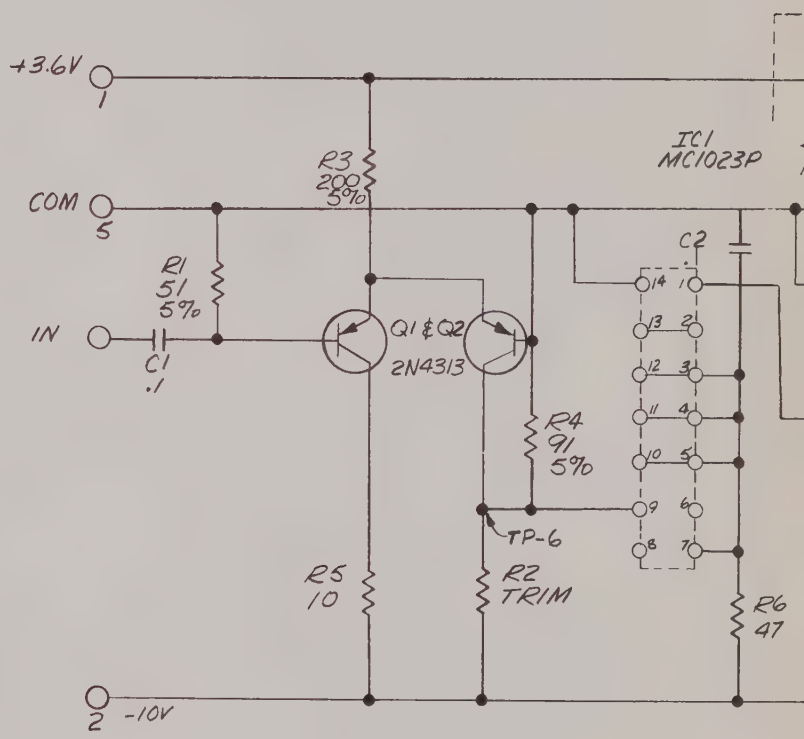
NOTES UNLESS OTHERWISE SPECIFIED.

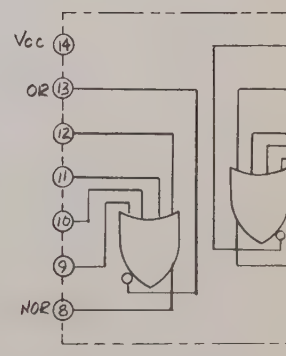
1. RESISTANCE IN OHMS, ±10%
2. CAPACITANCE IN MICROFARADS, ±10%
3. ALL DIODES ARE FD6666
4. NULL AMPLIFIER COMMON IS SEPARATE FROM FREQUENCY COMMON



LAST COMP DESIGNATOR
R23
C11
CR13
Q10

	A	ECN 174	MB	10/2	Am
tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale	by M E Bo	date 4-27-67	app J B		
material	title SCHEMATIC – POWER SUPPLY REGULATOR				
	model no 207, 701, 702	dwg no. 207-204A			rev
finish	this document contains proprietary information and design rights belonging to WAVETEK and may not be used or reproduced for any reason except calibration, operation and maintenance without written authorization.				





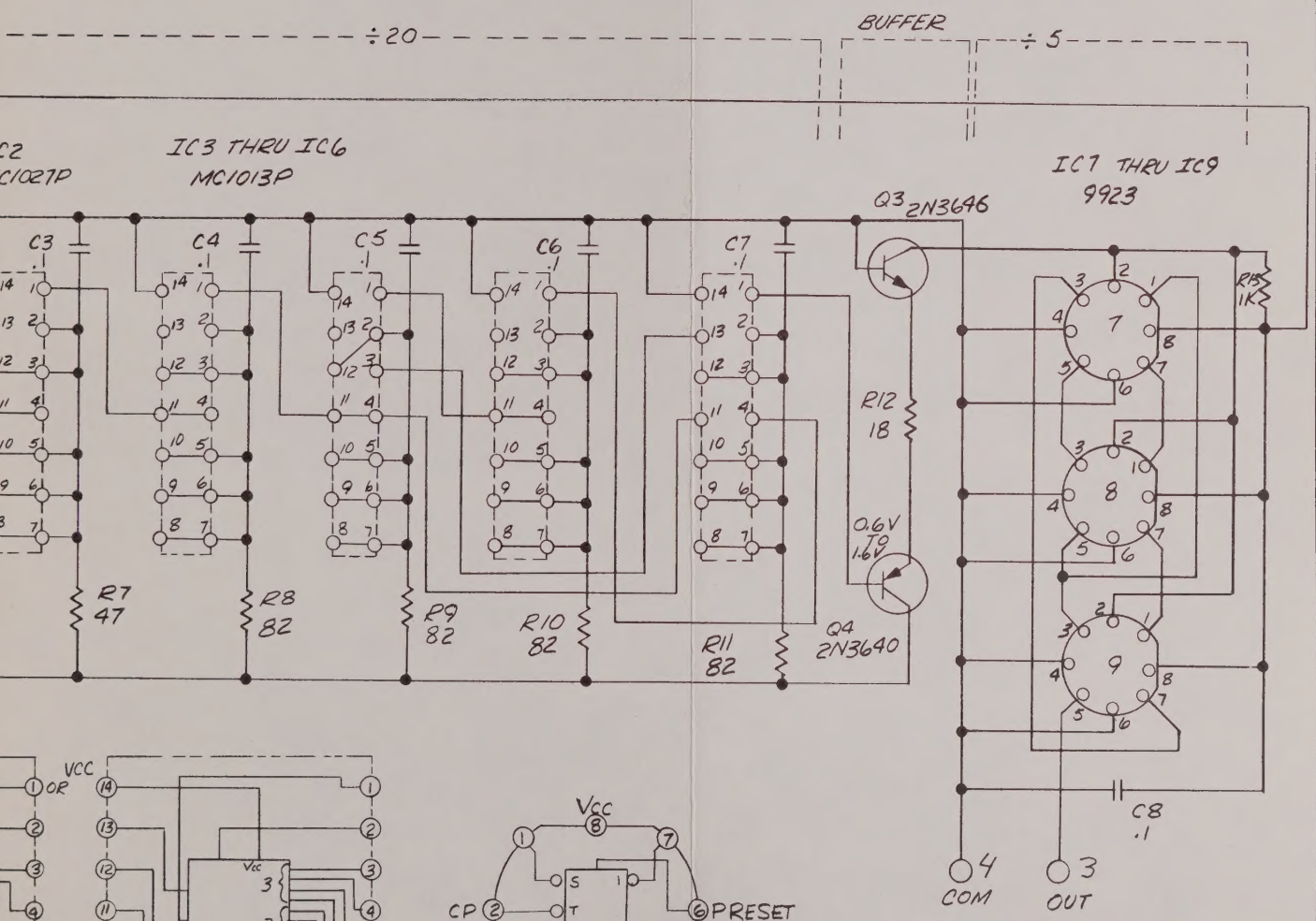
MC1023P

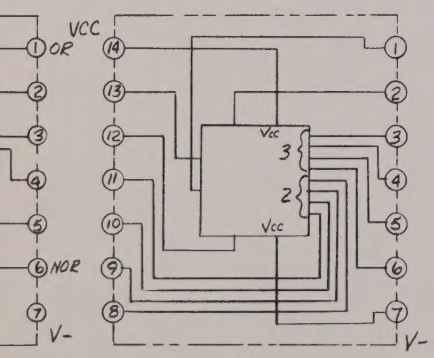
NOTES: UNLESS OTHERWISE SPECIFIED

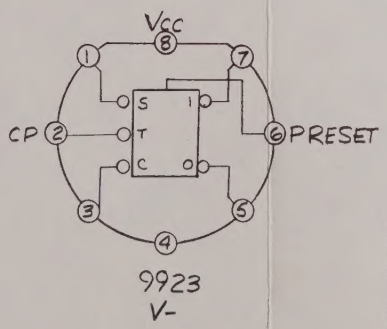
1. RESISTANCE IS IN OHMS, 10% ½W CARBON
2. CAPACITANCE IS IN MICROFARADS

LAST COMP DESIGNATOR

R13
C8
CR0
G4
IC9







tolerance unless otherwise specified .XXX ± .010 .XX ± .030	rev	ecn	by	date	app.
	WAVETEK san diego, calif				
scale	by ENH	date 11-29-67	app.		
material	title SCHEMATIC DIAGRAM RANGE EXTENDER				
finish	model no. 207	dwg no. 207-205	rev		

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